# HEALTH IN THE HOUSE.

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BUCKTON.

ELEMENTARY PHYSIOLOGY

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# HEALTH IN THE HOUSE

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TWENTY-FIVE LECTURES ON ELEMENTARY PHYSIOLOGY IN ITS APPLICATION TO THE DAILY WANTS OF MAN AND ANIMALS DELIVERED TO THE WIVES AND CHILDREN OF WORKING-MEN IN LEEDS AND SALTAIRE



BY

CATHERINE M. BUCKTON

MEMBER OF THE LEEDS SCHOOL BOARD

*SIXTH EDITION, REVISED THROUGHOUT*

LONDON
LONGMANS, GREEN, AND CO.
1876

THESE LECTURES ARE DEDICATED

TO MY HEARERS IN LEEDS AND SALTAIRE

AS A REMEMBRANCE OF THE PLEASANT HOURS

WE SPENT TOGETHER

*CATHERINE M. BUCKTON*

4 Moorland Terrace

# PREFACE

TO

## THE SIXTH EDITION.

It is now six months since this little book was first issued, and in that time it has attained a success beyond my most sanguine expectations. In preparing this new edition I have availed myself of the criticisms sent me by several of the scientific men whose books I studied, and I have also benefited by reading the numerous reviews which have appeared. I am glad to be permitted to mention that Mr. Marshall, F.R.S., who kindly gave me his advice during the revision of the original manuscript, has rendered me still further indebted to him by carefully reading through the book for the purpose of this edition; and by these means it has, I hope, been much improved. The present edition is published in a cheaper form, in accordance with numerous suggestions which have been made to me for extending its influence. I hope that my Lectures will, therefore, now come within the reach of those for whom they were originally written.

CATHERINE M. BUCKTON.

4 Moorland Terrace:
*Feb. 4th*, 1876.

# PREFACE

TO

## THE FIRST EDITION.

HAVING had two winters' experience in giving Lectures on Physiology and the Laws of Health to the wives and daughters of working-men in Leeds and Saltaire, I ventured to hope I might be able to make the same instruction interesting and intelligible to boys and girls in our Board schools, from the ages of ten to twelve. With the aid and concurrence of my colleagues on the School Board, about ninety children of both sexes, in Standards IV., V., and VI., were collected into one centre during the winter of 1874. As I wished to find out whether the children were really interested in my Lectures, I fixed upon an hour in the afternoon when their schooltime was over, and explained clearly that I only desired to have those who were anxious to come and could understand what I told them.

The following Lectures contain the substance of my teaching.

I must claim the indulgence of the educated public for the extreme simplicity of my style, and for the tautology which so frequently appears. They must kindly remember that my whole endeavour was to tell my story in language that would be understood by artisan children from the ages of ten to thirteen.

During five months the attendance averaged fifty. Several half-timers were obliged to discontinue coming on account of their work. Without one exception, the children proved most attentive and polite, and, I am told, looked forward with great pleasure to the lectures. The answers sent in weekly to my printed questions proved that the most important part of the instruction was understood—namely, the necessity for fresh air, cleanliness, good food, and the great harm that spirits do to the different organs. The germ theory enabled me to show very clearly the danger of infection. By the aid of Anatomy, and *Physiology* or *Anatomy* in connection with *Structure*, I described the beautiful structure and marvellous life of man and animals; and showed the awful amount of suffering that is caused by the cruel and ignorant practices of men and women. Physiology, when practically applied, becomes a most interesting study to persons of all ages, but when taught alone is, I believe, uninteresting, and soon forgotten by all except medical students.

The boys enjoyed the lectures on food and cooking equally with the girls, and it appears to me to be equally important that they should understand the properties of foods, and the principles on which they ought to be cooked.

To soldiers, sailors, and emigrants, such knowledge must be of vital importance. I cannot see how real success can attend any scheme for teaching cooking, unless this information has been previously given. Even a professed cook may prove a most extravagant poor man's wife, and a lady may attend lectures on *cuisine* for ever, and still be unable to rear a healthy family, and make small means go far.

During my lectures, I determined to plead the cause of dumb animals as well as little children. Great interest was taken in all that was related about them. I was pleased to observe the strong expressions of disapproval written and expressed, when instances were given of the cruel and ignorant way in which they were often treated. I believe the dreadful brutality now practised by human beings upon each other and upon dumb animals, will not be really diminished until young people are reverently taught how wonderfully their bodies are made, and the great care that is needed to preserve them in health. No schools require this instruction so much as our elementary schools, for it is from them we draw our supply of nurses, grooms, farm-servants, and butchers. The following circumstance shows that instruction of this kind exerts a humanising influence. A missionary told me he knew a woman who used to beat her children in a very brutal manner. Nothing that was said appeared to touch her heart, or change her ways, until she learned from the lectures how delicately and wonderfully a child is made; then her past cruelty presented itself in its true light, she was filled with sorrow, and ceased to treat her little ones unkindly.

My lectures were concluded by a visit to our Museum. Seventy-three of the children met me there, and they all looked with great interest at the animals I had described. Museums are essentially places for working-men and their children, therefore every effort ought to be made to enable masters and mistresses to follow up their lessons on natural history by visits to these places. At the end of my course of twenty-five lectures, I presented to each child fourteen questions, which bore on the information I had given respecting animals. These will be found in the Appendix, p. 199. Five prizes are to be awarded for the best answers by the Leeds branch of the Society for the Prevention of Cruelty to Animals, at their annual meeting.

I attributed my success in arousing the interest of my hearers to the pains I took to make the matter intelligible and attractive, by having models, illustrations, and experiments, and by giving the information orally. I was also very anxious to impress the children with confidence, so that they might come and ask questions at the close of the lecture. Prizes, I told them, would be given to those who showed by their answers that they had endeavoured to understand and remember what I said. This encouraged those who wrote and spelt badly to show their intelligence and do their best. I always read over the questions before I began the lecture, in order to draw attention to the most important facts, and I repeated the information which I found from the written answers I had failed to make clear in the previous week. My only regret was that I had not a larger supply of models, and a greater number of experiments; for instance, a model of the head and brain, and an experiment to show how water can be decomposed by a galvanic current into oxygen and hydrogen, and other illustrations which will readily occur to experienced teachers.

Instruction of such vital importance ought only to be given by persons who are specially fitted for the work, and can be provided with every appliance which science and skill can furnish. Directly the people are educated and understand that fresh air, good water, and cleanly habits, are necessary for their health and happiness, they will demand model dwellings, and also those sanitary reforms which ignorant corporations and thoughtless masters and mistresses now withhold from them.

Mr. Stansfeld expressed this opinion publicly a few weeks since at Halifax in the following words:—'Legislation will never make people clean, nor can any sanitary reform be accomplished until the masses are taught the Laws of Health.' Saltaire is well known as a model manufacturing town, where Sir Titus Salt and his family have done all that sanitary skill and money can accomplish.

Mrs. Titus Salt induced me, last winter, to give a course of lectures to their people, as she assured me that they were very anxious to receive the same information I had given in Leeds. Experience bore out this statement. My audience varied during six winter nights from two to five hundred working-women and their daughters, who received all I had to say, as my Leeds friends had done, with the greatest gratitude and eagerness. On all sides I heard the strongest regrets expressed that they had not been taught early in life what every woman ought to know.

My warmest thanks are due to all my friends in Leeds and elsewhere, who have so kindly helped me, either personally or by their writings, to cull the information contained in this little volume.

I should like to express my obligation to Mr. MARSHALL, F.R.S., the distinguished surgeon and physiologist, for the advice he was always ready to give during the revision of the manuscript. This kindness was doubly appreciated by me, as it was rendered voluntarily to the work of a perfect stranger.

I cannot conclude without also mentioning the name of Mr. WHEELHOUSE, F.R.C.S., one of our leading medical men. In the midst of his large practice he has always been ready to clear up difficulties which books failed to make plain. From the first he gave me his sympathy, and encouraged me to carry out my work by the assurance that the efforts made by the medical profession to hinder the loss of life and suffering caused by preventible diseases will ever prove unavailing until ignorant prejudices have been removed by sanitary knowledge.

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# HEALTH IN THE HOUSE.

## LECTURE I.

### *THE AIR WE BREATHE.*

I HOPE that the instruction I am going to give you during these lectures will soon be given to every boy and girl. My first reason for desiring this is because I know that there is so much sickness, suffering, and death that is entirely caused by ignorance about physiology and the laws of health. You will see I have written down on this big sheet a series of

*Facts that every Man and Woman in Leeds ought to know.*

| | |
|---|---|
| Number of men and women who died in Leeds in the year 1872, from preventible causes, such as Scarlet Fever, Typhus Fever, Small-Pox, &c. | 1,538 |
| Number of Children who died in Leeds in 1872, from Fevers, Croup, &c., and more especially from the want of a mother's care | 1,170 |
| Total number of deaths from all causes | 6,881 |

TO ENSURE GOOD HEALTH

We must have

Fresh Air,
Pure Water,
Wholesome Food,
Clean Houses,
Clean Streets,
Good Drains,
Proper Clothing,
Temperance,
Cleanly Habits.

It is very sad to think that 1,538 grown-up people and 1,170 little children died last year in Leeds, and die every year, whose lives might have been saved; but it is much more dreadful to know that nearly as many people who partly recovered from these complaints are still living and suffering from diseases left by fevers, small-pox, &c.

Many fathers and mothers with large families, who were able to work and support them comfortably before they had these illnesses, are now obliged to live in the workhouse. Poor little babies grow up to be miserable weak men and women, unable to gain their own living, obliged to be dependent on charity, because their mothers either neglected them when they were infants, or were too ignorant to understand how to bring them up.

My second reason for wishing to give you these lectures is because I am so grieved to see how cruelly and unkindly human beings treat each other, and also how cruelly poor dumb animals are used. I feel quite sure that young people would not be cruel if they were made early to understand how beautifully and wonderfully our bodies are made. I shall show you that dumb animals, though they cannot tell us how much they suffer, do suffer when they are hurt, because a great many of them are made very much like we are, and can feel like ourselves.

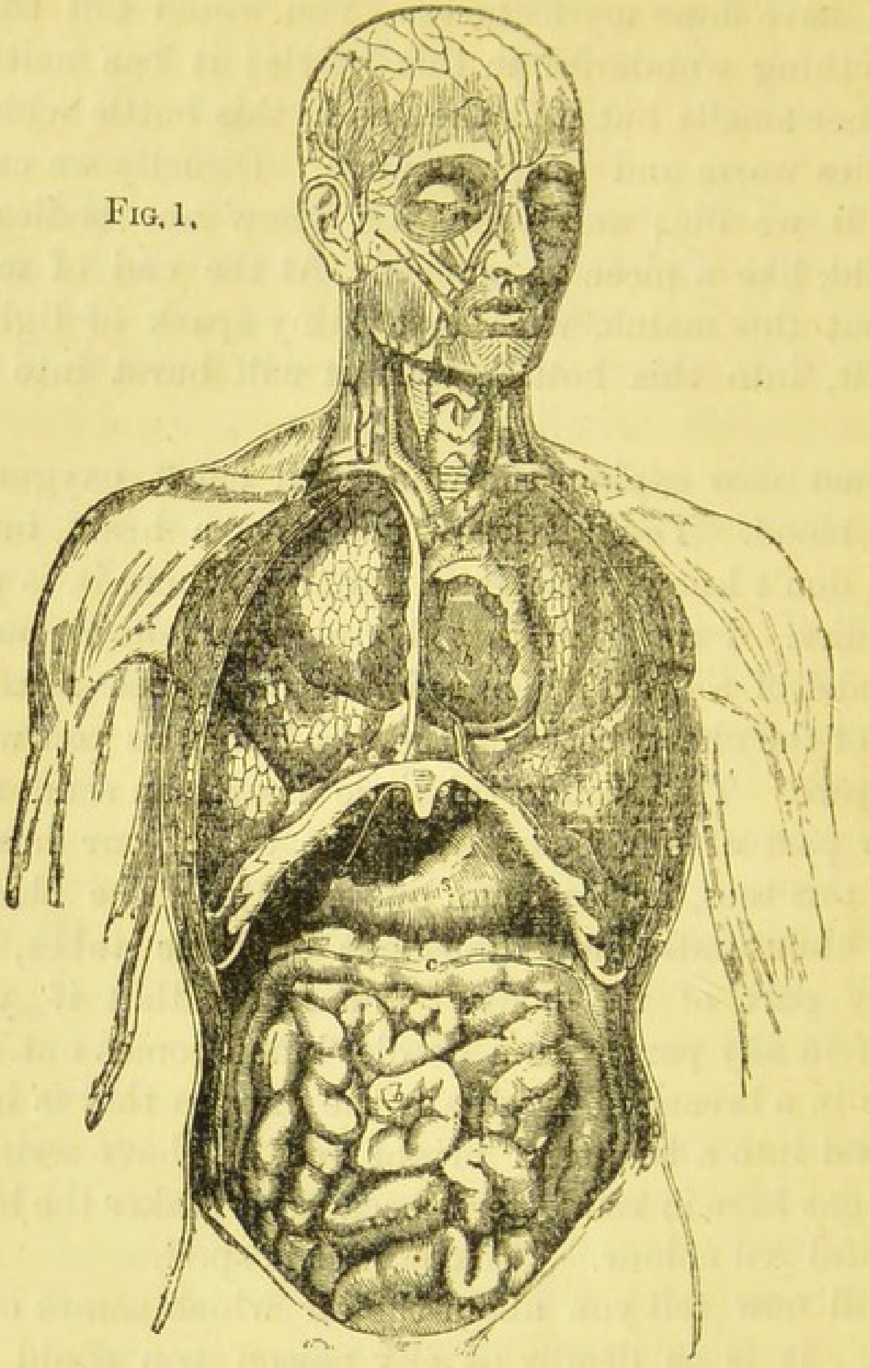
You see the first thing I have mentioned as essentially necessary, if we are to secure health, is good air. I will tell you why—because we could live about a week without either water or food, but we could not live two minutes without air. If a pillow were placed over your mouth and nose, you would be dead in two minutes, because no air could get into your lungs. We first draw in a breath of air, and then we send out a breath of air. This we do every instant of our lives, unless we have been crying, and then we sob and take in two or three breaths of air without letting one out, in this manner.

We breathe so gently and easily when we are well and have no cold, that we never think about how we breathe. The air we take into our mouths ought to be pure air and contain a great deal of the gas that is in this bottle. It is called oxygen gas. Now, this is the most wonderful gas in the world, and I shall have a great deal to tell you about it before I have done my lectures. You would not think there was anything wonderful in this bottle; it has neither taste colour, nor smell; but it is the gas in this bottle which makes our bodies warm and keeps us alive. Directly we can't have any of it we die; and then you know our bodies become quite cold, like a piece of marble. At the end of my lecture I will put this match, with just a tiny spark of light at the end of it, into this bottle; then it will burst into a bright flame.

I must now explain the wonderful effect oxygen gas has on our blood. You all know you have a heart, but I dare say you don't know what it is like, nor where it is placed in your bodies. I am glad to tell you I can show you a beautiful model of a heart; here it is. It is placed nearly in the middle of the chest, between the two lungs, as you will see by this picture. This wonderful little heart can send the blood to every part of our body, from the top of our head to the ends of our toes, in less than one minute. The blood is carried in thousands and thousands of little tubes, or pipes, to every part of the body. You know that if you prick yourself in any part with a needle, blood comes out. Directly we take in a breath of fresh air, the oxygen that is in it turns the blood into a beautiful bright red. I have written down oxygen gas here in red letters, because it makes the blood such a beautiful red colour. Look how it is spelt.

I will now tell you about the air which comes out of our mouths. It is as deadly as any poison you could buy at a druggist's shop. On a cold day you can see the breath coming out of your mouths, and it looks like steam. Breathe on a pane of glass, and you will see directly a white film. If you were to sit in a room that had no windows, and the door was shut fast, so that no fresh air could come in, you would soon die. The name of the poisonous gas that comes out from our mouths is carbonic acid; it is written down here in black letters, because it turns all our blood dark and thick, and this dark blood poisons the brain, spinal cord, nerves, and heart, and so we die. I have got some here in this bottle, and I will show you at the end of the lecture how heavy this gas is. Like air, it cannot be seen, but I can pour some of

Fig. 1.



Front view of the inside of the chest (*thorax*) and abdomen, laid open by taking away their outside coverings, the ribs in front of the chest having been removed. The tip of the breast-bone (*sternum*) and part of the cartilages of the seventh and following ribs, are kept, as the diaphragm, which separates these two hollow parts of the trunk, is fixed to them. In the chest are seen the right and left lungs *l l*; and between them the bag of the heart (*pericardium*), laid open to show a part of that organ *h*. Passing up from the heart to the sides of the neck are the great blood-vessels, the *aorta*, the vein *i*, between which are seen the wind-pipe and the larynx. Below the diaphragm, and therefore in the abdomen, is seen, projecting below the right ribs, a part of the liver *a*. From a notch low down projects the gall-bladder. Under the liver, and to the left, is the stomach *s*, at the left end of which is seen a piece of the spleen; below is the great bowel *c*, or intestine, which goes nearly round the small bowels, or intestines, that lie twisted about in the middle. Lowest of all lies the bladder. When you look at a diagram in a book, you must remember that you are standing opposite to the figure which has its back to the page. Your right hand therefore will be on the left in the figure; what is on your right in the figure, will be on your left side really.

it from that bottle into this bottle, because it is heavier than air. I will put a lighted candle into it, and out it will go. Next week I will let one of the boys or girls fill a bottle with the air that comes out of their mouths, and you will see that it contains some carbonic acid gas, for it will put out a candle just in the same way that this gas will put out a light.

There was an emigrant ship that sailed from Liverpool a few years ago. This vessel was going to ——. The men and women and children on board were going to leave old England to work in a strange land. They were emigrants. One night a dreadful storm arose. The ship tossed about so much that the captain ordered the sailors to send all the men and women and children down into a large room under the deck, because he was afraid they might be in the way. The sailors fastened the door so that they could not get out. The storm went down in a few hours, when the captain told the sailors they might open the door, or hatches as they were called. The sailors took a candle, because the room where these poor creatures were put was quite dark. When they entered, the candle went out. They lighted it again, and it went out a second time. This was done several times. At last it remained alight, and so they were able to descend. And what do you think they found? Nearly all the men and women and little children lying on the ground. Some were dead, others unconscious. The only air they had had to breathe was the air that had come out of their mouths. No oxygen had been able to get in, so they had been poisoned by carbonic acid gas.

I must tell you that all dumb animals which have a heart like ours also die if they cannot have good air containing a large quantity of oxygen. About a year or two ago a ship brought over a large number of sheep from Holland. They were fastened down in a room such as the poor emigrants were placed in, where no pure air could enter. When the hatches were opened, it was found that six hundred and forty-six were dead, and had to be thrown overboard. When animals have been cruelly treated, deprived of good air and good food, they have fevers, consumption, and other complaints. Some butchers kill them in this diseased state, and sell their flesh, which is unhealthy, and must do harm to the human beings who eat it.

Owing to our ignorance, we often have to sit in rooms which are filled with this impure air, which poisons our blood. Fortunately, some of this poison is able to get out through our mouths in the breath and through our skins in sweat. You know on a summer's day, when you have run or walked quickly, how the water runs down your face and you feel wet all over. Now, this sweat contains some of the same gas that comes out of your mouth. It is deadly poison. Even during the winter, when our hands feel quite cold, there is a great deal of this steam coming out of our skin. It is called invisible perspiration or sweat, because you cannot see it. When it runs down your face, it is called visible perspiration, because you can see it. I think you will be astonished when I tell you that in winter as well as summer, if we are in health, more than two pints of perspiration ought to come out daily through our skin. There are thousands and thousands of little holes in our skin, smaller than the point of a needle. Each of these little holes leads into a little pipe of twisted skin, like this model of a sweat gland, made of glass, which I hold in my hand. It is through these little pipes that the sweat is carried and runs out through the little holes in the skin. It is said that if all these little pipes of flesh, called sweat glands, which are in one person could be pulled out straight, and fastened together, they would reach a distance of twenty-eight miles. Now, supposing that all these thousands and thousands of little glands were shut up, so that the two pints and more of sweat could not get out, what do you think would happen? Why, you would die, as the following story will prove.

A long while ago, in Rome, there was a grand feast or festival. People were drawn about in carriages ornamented with flowers. Somebody thought that one of these carriages would look most beautiful if a little boy, dressed like an angel, could be placed in the middle of it. They covered the whole of his body with gold, and fastened on to his shoulders a pair of gold wings. The little fellow was considered to look very lovely. When his mother went to see how the little angel looked next morning asleep in bed, she found he was dead. The gold had completely closed all the pores, or little holes, in his skin, and therefore he had been poisoned by the sweat and carbonic acid that could not get out.

All four-footed animals have pores and sweat glands, just as we have, except those which have a bony covering. If you were to varnish a guinea-pig—that is, cover it all over with paint—it would die for the same reason that the little Roman boy died. The sweat could not get out.

It is very important to know that both air and liquids can enter these holes in our skin as well as come out of them. Sailors who have been cast on a rock for three or four days have been prevented from dying of thirst by knowing that, if they kept wetting their clothes in the sea water, the water would get through these holes into their blood. It would have been impossible for them to drink the sea water, because the salt in it would only have made them more thirsty. Fortunately the salt does not enter the skin, only the water without the salt.

A gentleman was once so ill that he could neither eat nor drink anything, and must therefore have died. The doctors managed to keep him alive for two or three days by putting him frequently into milk baths. The milk got through the pores of his skin and nourished his body. After this time he was able to eat and drink, and soon recovered.

A great deal of oily matter likewise comes out of the skin, and it is owing to this oily matter that it is quite impossible to get the dirt off your hands and face unless you use soap.

*Soap* mixes with oil, but *water* will not. A working-woman who attended some of my lectures last winter told me that she had often been 'fair capped' to find that she could not get off the dirt unless she used soap, 'but now,' she said, 'I understand the reason why, and am very much obliged to you for telling me.' I hope you will never forget to wash yourselves well every morning and night with plenty of soap and water.

*Things provided for the Lecture.*

Marshall's diagram of the heart and lungs, and Auzoux's model of the heart.

A large sheet upon which the death-roll and the laws of health were printed.

A drawing of a small piece of the palm of the hand, with three sweat glands blown in white glass suspended from the pores.

The words 'Oxygen Gas' written in large red letters, 'Carbonic Acid Gas' written in bluish-black letters on two sheets of calico.

Two glass bottles filled with oxygen gas.

Two glass bottles filled with carbonic acid gas.

Common matches and a candle.

A high tumbler into which to pour the carbonic acid gas.

*Experiments* with carbonic acid gas, to show how it extinguishes light, and is so heavy a gas that it can be poured from one vessel into another, and if poured over a lighted candle will extinguish it.

All difficult words to be written large on a sheet, and the children to be told to copy them *at every lecture.*

### *Questions for the First Lecture.*

1. What is the name of the good air that gives heat and life to our bodies?
2. What is the name of the bad air that comes out of our mouths?
3. Why do human beings and dumb animals die if they are shut up in a room where no fresh air can come in?
4. If all the sweat glands that are in our bodies were joined together, how far would they reach, and how much perspiration comes out of them daily?
5. Why is it necessary that we should wash ourselves daily with soap as well as water?
6. If you were in a boat on the sea without any fresh water to drink, how would you prevent yourself from dying of thirst?

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## LECTURE II.

### *IMPURE AIR AND VENTILATION.*

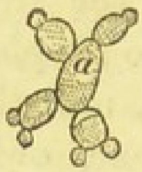
I TOLD you last Wednesday that many thousands of people now die in England every year from complaints they would not have if the laws of health were understood, and that thousands and thousands of people live to suffer all their lives because they have had fevers and other preventible diseases. Three or four hundred years ago a great many more people died of even more dreadful complaints than those we have now. I don't think you will be surprised at this when I tell you what dirty houses people lived in, and what dirty habits they had. London, which is now such a grand city, in those days had only narrow little streets like Fleece Lane in Leeds. Fleece Lane, you know, is so narrow that the sign of a sheep which is hung up just reaches from one side of the street to the other. In London they used to have a great many similar signs, which were suspended across the streets and prevented the fresh air from passing through these dark places. To make matters worse, the streets also contained pigsties and middens. They had no fireplaces; the wood was burnt in the middle of the room, and the smoke escaped as it could. Carpets they had none, only straw, which was allowed to remain for more than ten years; every now and then a fresh quantity was put over the old straw, and at last it was all thrown out into the narrow dirty streets I have already described.

Fevers are caused by some poisonous matter which floats in the air, or which has got into the water we drink. It is only about a hundred years since Dr. Priestley discovered this wonderful oxygen gas of which there is so much in the air we breathe. He was a very scientific man, and lived for some years in Leeds, where he had previously discovered carbonic acid gas. Most people thought, before that time, there was nothing in the air, because they could not see anything. I am thankful to tell you that at this present time in England some of our cleverest men are spending their whole time in trying to find out all about the air we breathe. They have already discovered so much about it that they can weigh air in a pair of scales just as you would weigh sugar or tea. They have such powerful magnifying glasses that by looking through them they can see the things that are floating in it. They have long been able to look into water and discover what it contains.

Now, in this little bottle of water there are a great many living things. Neither you nor I can see them now; but if you look through this magnifying glass, which is called a microscope, you will see them, and will find among them creatures like that drawn on this sheet called the Amœba.

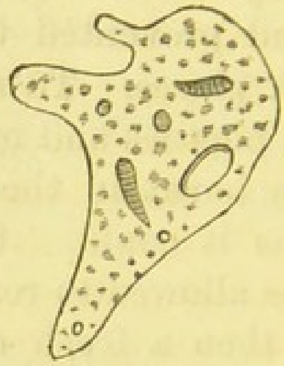
These very small things called 'germs' are the beginning of life in all plants and animals. There are animal germs and vegetable germs. You all know German yeast, or brewer's yeast, which your mothers put into the flour to make the bread rise.[1] Now, if you could look at that yeast through a microscope, you would find it is made up of millions and millions of

Fig. 2.




Microscopic Plant—Yeast Plant.

Fig. 3.



Microscopic Animal—Amœba.

little germs, or seeds, like this. A thousand of them will grow in a minute from only one seed.

The very simple microscopic animal of which I have showed you a drawing, is called the Amœba; it grows quite as quickly as the yeast plant. I must tell you that the yeast plant and the Amœba are both harmless to man. There is life in everything we eat or drink and in the air we breathe. I could show you that there is life in sugar, vinegar, cheese, &c.

There are germs and little creatures of two kinds. Some are wholesome, like the germ in yeast and like the Amœba; others are unwholesome. The germs that are in good air and good water are wholesome germs, but those that are in bad air and bad water are poisonous, and when they get into our blood they give us fevers, cholera, &c. The air that comes from drains and middens is full of poisonous germs; they breed also in any dirt that is allowed to stand for a long time. I am glad to tell you that directly the oxygen which is in fresh air mixes with them, and the foul air which is their food is removed, they die.

You see I have a grey substance in this bottle which is called permanganate of potash. It is very cheap, though it has such a long name. Now, this stuff contains a great deal

[1] Here I showed some yeast.

of oxygen. If you were to put any clothes from a person who had had a fever into a tub of water with some permanganate of potash in it, all the poisonous germs that had come from the body of the sick person would be killed. Here I have some water which has some permanganate of potash in it. You see that its colour is a beautiful deep purple, and I will put some of it into this pure water. The colour remains as bright as ever. Now I will put it into some water that contains a poisonous substance, and you will see that the colour immediately flies, and the water will look a dirty yellow. What a blessing it is we can get this wonderful oxygen gas without paying for it! All we have to do is to open our windows and doors and let it rush in, and then it will drive away and kill all the fever germs.

During those times I have just told you about, when people had such dirty habits and suffered from dreadful fevers in England, how do you think they treated a poor man, or woman, or child, who had a fever? They used to shut them up in a room, and close the windows, so that not a breath of fresh air could come in. The bed clothes were never changed; all the poisonous matter that came out through the skin as sweat and oily matter was allowed to remain and collect, so it again entered the blood through the pores of the skin and poisoned it more and more. Blankets were put upon them to make them sweat. When the unfortunate person became mad with the fever and the treatment, he was tied down to the bed. No wonder he died. Even the doctors, as a rule, in those times did not understand anything about the laws of health. They used to treat people in the small-pox just in the same way.

In 1731, more than a hundred years ago, small-pox was very bad at a place called Blandford. There were 150 persons ill in one hospital. One night—it was summer-time—a fire broke out. All the sick people were carried out and put into the fields under bridges, under hedges, anywhere, and there they remained three days and three nights. Everybody expected they would die directly, but instead of that they all got well, except one poor girl, who was nearly dying when the fire broke out. How delightful it must have been for the poor creatures to have plenty of fresh air blowing upon them, instead of being shut up in close rooms.

It is most important that no clothes should be kept in a room where anyone has a fever. If I were a poor woman with six children, and had only two rooms to live in, and found one of my children was sickening for a fever, I should immediately take all the clothes out of the drawers, bundle them up in a parcel, put them into the other room where I lived, remove every bit of curtain and carpet, open the window at the top about two inches, or break a top pane of glass if it would not open, see that the fireplace was open, or, if it was not very hot weather, light a small fire. Then I should warm the bed give the child something hot, and send for the doctor.

Germs float in the air, settle upon the furniture and the walls, and get caught in articles of furniture, carpets, bed-clothes and wearing apparel; they live best in woollen materials, which seem to keep them warm and feed them. Cobwebs are of a silky nature, and cases have been known where one cobweb has held sufficient germs to give a fever over again. It is right on this account that a nurse should wear a cotton dress.

I will tell you a story that will prove how well woollen material will retain the germs of a disease. During those ignorant, dirty times in England long ago a dreadful complaint, called the Plague, used to rage. It visited England many times in the course of several hundred years. Directly it was known that anyone had this complaint, no one would go near him; he was allowed to die alone—so great was the dread of it. In a village called Eyam in Derbyshire, in 1666, a tailor lived, named George Vicars. One day he received a box of clothes from London, containing such articles of clothing as coats, trousers, &c., all made of wool. He opened the box, and spread these things out to air before the fire. As he stood watching the clothes dry he felt sick. The heat of the fire no doubt brought the germs to life, and they floated about in the air, and he breathed or swallowed them. The next day he was worse, and on the third day a black spot appeared on his breast. Then he knew that he had the Plague. He died that night. No doubt people went to his funeral and into the house to see the corpse. Those clothes, too, which had come from London, as well as his own, would be worn by different members of his family. In a few weeks after the funeral the Plague broke out in this beautiful little village. The people became so terrified that they wanted to run away to other towns, but the clergyman, a good and brave man, Mr. Monpesson, persuaded them to remain, so that the Plague might not spread to other towns. Nearly all the people died. Still Mr. Monpesson remained and did all he could. At last he lost his wife. The churchyard became so full of graves that no one dared to enter it or the church, so it was closed. On a Sunday the people used to pray out in the fields. If you ever go to Eyam, you will see a little cave in a rock which is all covered over with ivy. It was there that Mr. Monpesson used to perform the service to the few whose lives had been spared. Though nearly two hundred years have passed since those dreadful days, there are people at Eyam who will tell the story I have told, and a great many other most interesting facts about the Plague.

The germs or poison of scarlet fever can live in woollen materials for several years. A little girl died of this fever; her favourite doll was put by in a woollen dress. Three or four years afterwards a little cousin came to pay a visit at the house, and the mother, to amuse the little girl, brought out the doll. Not more than a week elapsed before the poor child was seized with scarlet fever. It is very wrong of mothers and fathers to send their children to school when they are recovering from scarlet fever. During that time the skin peels off, and that skin is full of germs, and one boy or girl in this state can spread the fever through the whole school. The hair of the head, being of a woolly nature, may hold the germs for a considerable time, unless it be well washed with hot soap and water and permanganate of potash.

I am now going to tell you how we can ventilate a room—that is, make the air fresh and free from all infection. You will perhaps think that you could make the air fresh by opening a window. I will show you that you cannot make the air fresh unless you have an open fireplace as well as an open window.

You see this little kettle with the steam coming out of the spout. Why does the steam rise up instead of falling down? Because hot air is much lighter than cold air. Our breath also rises like steam, because it is warmer than the air about us. If you remember, I told you that if I had anyone ill in a fever I should open the window at the top or break a hole in a top pane of glass, unless it was very cold, but in any case if there was no chimney in the room and the room was small; that was because I wanted to allow the carbonic acid gas, which is light when it is warm, though very heavy when it is cold, to fly through the opening in the top of the window, or, at all events, to mix it with fresh air. Cold air is always running after hot air, for as the hot air rises cold air rushes in to take its place. If you heat the air in a room by means of a fire, the warm air will go up the chimney, and cold air will come in to fill up the gap; so hot and cold air are always chasing each other. Do you not know, when you are sitting by a fire on a cold winter's night, how the wind whistles through the key-holes, pushing its way under the door? It is only because the cold air is rushing after the hot air escaping from the room.

I dare say you have all been at home on a washing-day, and seen the room full of steam. You will find that if you open the bottom part of the window the steam will not go out of the room, but if you open the top about two inches it will fly out quickly enough. Tell your mothers about this. Directly the steam gets cold at the top of the room, it falls down like rain, and covers the furniture and clothes, so that they become wet. A mother told me once that her little boy often suffered from bronchitis after a washing-day, but on following my directions about opening the top of the window the child did not suffer from his old attacks. It is dangerous to sit in a room with the bottom part of a window open, as it often causes a draught to blow directly upon you; but you do not feel the air when it comes from a window that is open a little at the top. In our house we all sleep with our windows open at least an inch at the top both summer and winter, and we never take cold. The room feels so fresh when we awake in the morning because the carbonic acid gas has been able to make its escape.

I will now tell you a story which will prove that there ought to be a fireplace in every bed-room as well as sitting-room. In 1782 seventy-three pauper children, between seven and fourteen years of age, were sent to a new house in Golden Square, London. Twenty of these children (girls) slept in a room together. In fourteen days they began to have dreadful pain, were sick, and became delirious. The doctor could not imagine what caused the illness, as there were eighteen girls who slept in the next room, and they were all well. The doctor ordered that the sick girls should be moved into a much larger room, where they recovered. They found out that the chimney of the room in which the girls had first slept was quite closed up with bricks. The window and door being also closed, the carbonic acid gas could not escape, and the air had become so bad that it had poisoned their blood. Now, do remember, all of you, to take care and see that the chimneys of your rooms are not stuffed up with bags.

When we take lodgings at the sea-side, directly we go into our bed-rooms we look up the chimneys. I am sorry to say we generally find they are quite filled up. They say it is to prevent the dirt from coming in. Then we have to order that the bags be taken away. If you have no fireplace in your room, be sure you have the window a little open at the top. You now understand why it is good to have a fire in a bed-room where there is sickness, because it causes the cold fresh air to rush in through the room after the warmer air that is escaping up the chimney.

*Directions how to attend to a sick person's room, so that the germs of infection may not escape into the next room, or be spread by sending the dirty bed linen and clothes out to be washed.*

Remove the carpets and all the furniture that is not quite necessary.

Keep an earthenware pan in the room filled with clean water that contains a proper quantity of permanganate of potash. Directly any bed linen or clothes require to be washed, put them into this water for five or ten minutes, or into boiling water, if there is no permanganate of potash, as no poison germs can live long in boiling water. If water is only *warmed* it makes them grow more quickly. Washer-women and their families often lose their lives by fevers taken from clothes that have come straight from the body or bed of an invalid. I cannot understand how people can do so wicked and so cruel a thing as to send poor washerwomen clothes in this dangerous state.

Instead of sweeping the floor, use a damp mop. A great deal of woolly matter collects under all beds: so take it all away with the mop. Dust the furniture with a clean damp duster that has been wrung out of the pan of water. If you dust any room with a dry duster, and do not very often shake it out of the window, you had much better not dust at all, for you only make the dust fly about in the air you breathe; after a little time it will all settle on the furniture. A packet of permanganate of potash that costs one shilling will make twenty gallons of water sufficiently strong to destroy all germs of disease. One teaspoonful will make two gallons. *Great care* must be taken to mix the powder until it is quite dissolved. It is sold by all druggists.

N.B. After a fever or any infectious complaint, all bedding can be purified free of expense, if a post-card be sent to the Inspector of Nuisances. He will be only too glad to send for the things immediately, and place them in the hot-air apparatus, which will kill all germs of disease, without injuring the bedding. They will be safely returned directly they have been purified.

### *Things provided for the Lecture.*

A picture of a microscopic animal and a vegetable germ.
Some German yeast, to show what the yeast plant is like.
A bottle of water containing life which is invisible to us.
A microscope.
A bottle containing a solution of permanganate of potash.
A bottle containing some decomposed organic matter.
One bottle of oxygen gas.

### *Questions for the Second Lecture.*

1. What are germs, and how can you kill them?
2. Why is it dangerous to send a child to school when it has had scarlet fever and the skin is peeling off?

3. If a room were full of steam, how would you send it out?
4. How would you bring fresh air into a room and send the bad air out; that means, ventilate a room?
5. Why did people have dreadful fevers and the plague 200 years ago?

### *Experiments.*

Pour some of the solution of permanganate of potash into pure water; the purple colour will remain bright.

Pour some into the bottle containing organic matter; the colour will be changed to a dirty yellow.

Fill a bottle with water and place it with its mouth downwards on a stand in a tub of water. Then put a glass tube to the mouth, and ask a child to come and breathe through it. The water will be soon displaced by the air charged with carbonic acid gas that comes from his lungs. Put a cork into the bottle while it is quite under water. Now take the bottle out, remove the cork, and put in a lighted taper; it will be immediately extinguished.

Put a taper with a spark of light into the bottle of oxygen gas, and it will instantly burst into bright flame.

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## LECTURE III.

### *THE SKELETON.*

Before I begin my lecture to-day I must tell you about a society there is in Leeds for the prevention of cruelty to animals. Several ladies and gentlemen who cannot bear to see dumb animals unkindly treated, give their money and engage men whose duty it is to go about and see that horses, donkeys, and all dumb animals are well used. This society has heard that I am going to give you some information about dumb animals, and they have offered to present three prizes for the best answers to twelve questions I intend to give you when I have finished this course of lectures.

After my last lecture about impure air you will see that it is impossible for human beings to be healthy and strong unless they have plenty of fresh air. I will try to-day to make you understand why good air is equally necessary for dumb animals. Horses, cows, sheep, dogs, birds, and all animals except man were made to live night and day in the open air, and wander about in search of food. Birds, for instance, fly many hundreds of miles in a day in search of food. We take them and shut them up in cages so small that there is scarcely room in them to move, much less fly. These cages are often hung up in close rooms or by a window where the sun shines so strongly that the poor birds pant for air and long to fly into their shady woods, where it is cool and dark. I think it is very cruel and selfish to keep any animal shut up just for the pleasure of looking at it, or in order to hear it sing. Even men who are considered to be educated do not understand that all animals will die in air that has no oxygen. This I will prove by the following story.

In the Zoological Gardens in London are to be seen animals which have been brought from foreign countries; monkeys among the rest. They are very delicate, as they come from hot countries, where they live out in the woods. A great number used to die every winter, because our climate was too cold for them. Some gentlemen determined that they would build new monkey-houses, and make them so warm that it would be impossible for them to feel the cold. To their great surprise, more monkeys died than ever in these snug abodes. At last it was discovered that, as every little hole was filled up, no fresh air could enter. The poor creatures had been poisoned by their own breath—overcharged with carbonic acid gas.

I told you in my first lecture that an immense number of people die every year owing to our ignorance of the laws of health. For the same reason you will find that an immense number of animals most valuable to man die every year—the cow, for instance. Let us see how many different kinds of food we get from the cow alone: milk, cream, butter, cheese, and beef; veal comes from the calf, or young cow. Butcher's meat and all these kinds of meat are very dear. The farmers, who ought to take care of their cows, don't understand that they require as much care as human beings. Cows die by thousands of consumption every year in the British Islands. Consumption is very often caused by breathing bad air. A veterinary surgeon in Leeds (that means a doctor who tries to cure cattle) told me the other day that whenever he was sent for to see cows that were ill of fever or consumption, he found them living in horribly dirty stables, and when he told the farmers that they must clean the place by taking out the dung and whitewashing the walls, &c., they only laughed at him. The greatest care, of course, ought to be taken of all animals who furnish us with food. If they are not healthy when the butchers kill them, their flesh will of course be bad for us to eat.

Pigs have a dreadful complaint called measles. People who have eaten their flesh, which, you know, is pork, ham, and bacon, have taken this disease, and died after suffering great agony. Pigs get this disease owing to their not having been kept clean and properly fed. Sheep also die by thousands of measles and all kinds of diseases. All this ignorance has helped, in a great measure, to make butcher's meat very dear, because the cattle have become so scarce. We are now obliged to fetch them from foreign countries.

You have all heard of the cattle-plague; it was brought from Russia. There they treat their animals just as we do. For a long part of their journey these poor creatures are carried by railway in dirty carriages, so closely packed that they can scarcely move, and then they are driven and huddled together on board vessels, and suffer terribly at sea. Very little food or water is given them on the journey and voyage. Even healthy animals so treated would become unhealthy during their long journey. Don't you think it is quite right that we should suffer for our ignorance and cruelty, as we do, by having to eat diseased meat, and also by losing our own cattle, to say nothing of what they have to undergo? This is all I shall say about dumb animals to-day.

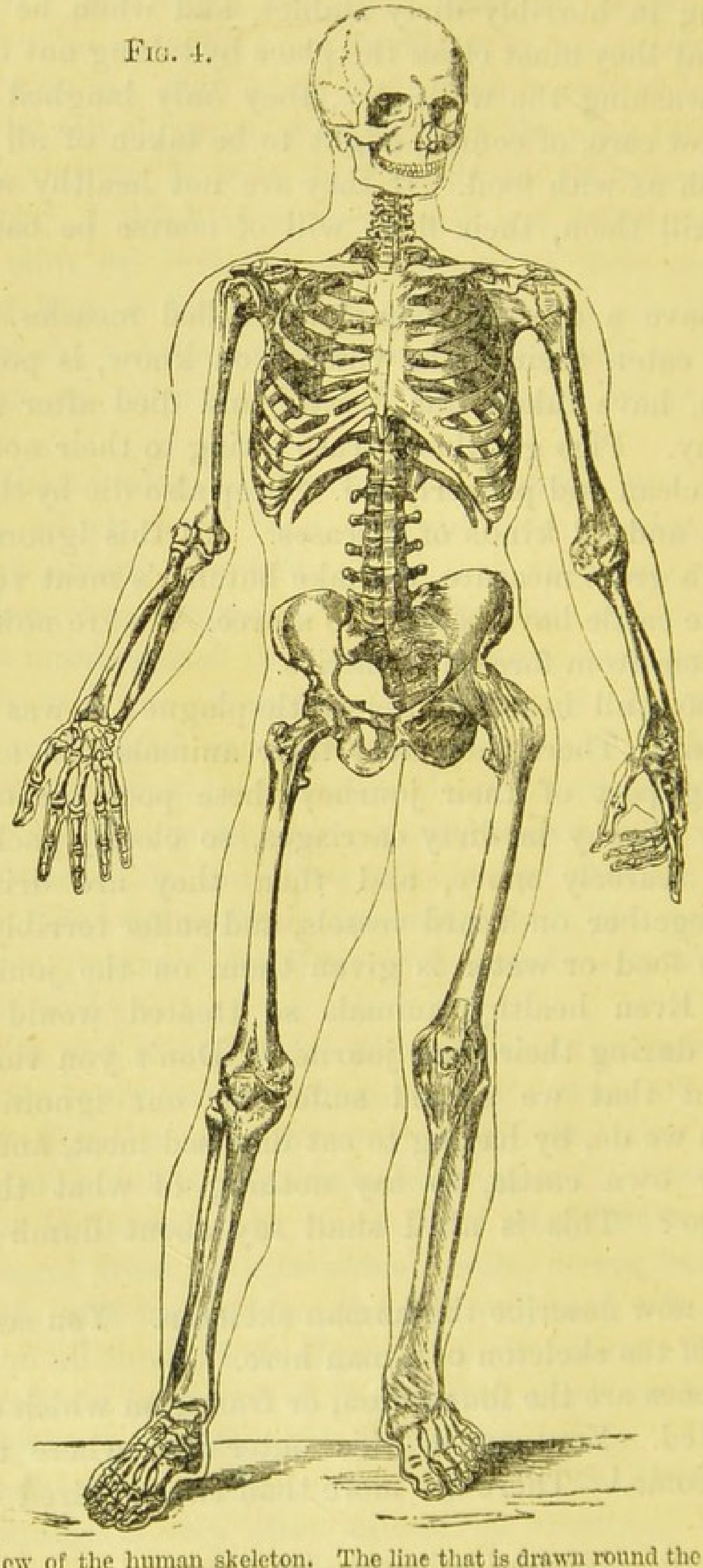
I shall now describe the human skeleton. You see I have a picture of the skeleton of a man here.

Our bones are the foundation, or frame, on which our flesh is supported. You see by this outer line where the flesh ought to come.[1] There are more than two hundred bones in

[1] Marshall's diagram, No. 1, page 20.

the skeleton. Our frames consist of three parts: the head, the body or trunk, and the arms and legs.

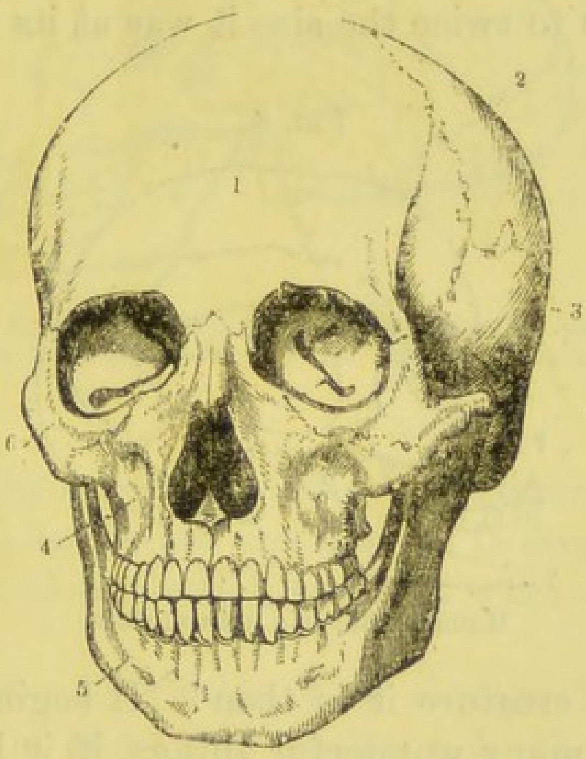
Fig. 4.



A front view of the human skeleton. The line that is drawn round the skeleton shows where the flesh would come in a life figure.

I will first tell you all I can about the head. When I say the head, I mean the head and the face also. The bones of the head and face are twenty-two in number, and they form the skull. This is a very strong box of bone; I hold one in my hand. It is the skull of a young man. You see that the top of it is round, not flat; it is in the shape of an arch. Now, an arch is the strongest shape in which the skull could be made, just as an arched bridge is the strongest shaped bridge which can be made to bear the heavy loads that have to pass

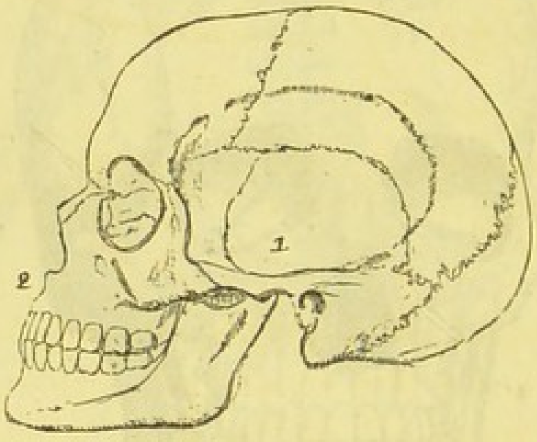
FIG. 5.




The bones of the head, which consists of the cranium, and face: 1, frontal bone; 2, left parietal bone; 3, left temporal bone; 4, right upper jawbone; 5, lower jawbone; 6, right cheekbone. This figure also shows the two eye-sockets, or orbits, the opening leading into the right and left nasal or nose-cavities, and the arrangement of the teeth in the jawbones. The head has eight, and the face fourteen bones. (*From Nature.*)

over it. You know that men can carry very heavy things on the top of their heads. Why do you think our skulls are so strongly made? Let us see what they contain—our eyes with which we see, our ears with which we hear, our mouths where we eat our food, the nose which enables us to smell, and then our brains. Without brains we should have no reason or power of thinking. Our skulls therefore hold our senses of seeing, hearing, taste, and smell. It is a very precious box, I think. There are, as I have just said, twenty-two bones from the face to the back of the head. If you were to see the skull of a baby, you would be able to find out where the bones join, and you could see how curiously many of them fit into each other, like two saws that joiners use to saw wood with. These bones are either gristly or membranous for some time; at about four years of age they become firm; at seven they are quite hard and well joined together. A new-born infant has a very soft and imperfectly matured brain; it can neither see distinctly, walk, nor talk; all it can do for a great many weeks is to eat, sleep, and cry. Very few animals are born so helpless as a baby. By the time it is a year old its brain has grown to twice the size it was at its birth. What a

Fig. 6.



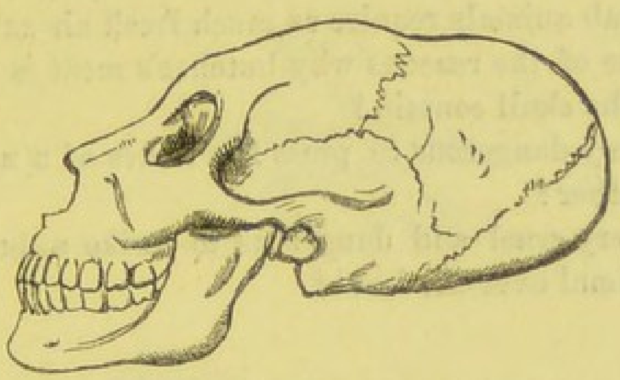

Human skull in a natural state.

wonderful little creature it is then! It begins to walk, talk, and do a great many wonderful things, if it has a good and wise mother. A bit of brain grows every day, and then just enough bone grows to cover the new brain; this is the reason why the bones of the skull are neither hard nor joined together when it is born. You will always find there is a wise reason for all the changes that take place as we grow older.

I dare say you have heard of the North American Indians. They are a wild race of men; they do not live in houses nor wear clothes, as we do; they think a baby's head ought to be made flat, and not left as God made it. So they put the little child into a kind of long tub and place a hard piece of stuff over its forehead, and then they squeeze it down tight with strings for some time, until it grows to be like this picture. The eyes nearly jump out of its head and are horrible to look at. By beginning directly the children are born, the shape can easily be changed, as the bones are soft.

I am sorry to tell you that in England, where we think we are so clever and civilised, little babies are not much better treated than those of the North American Indians. A great many English nurses have the same silly notions. They too think they can make the shape better; so they often press the

Fig. 7.



The skull of a North American Indian flattened in infancy by means of pads placed on the top and held down by strings fastened to the sides of a tub in which the child was placed.

bones of the baby's head together. They must fancy it is a mistake that the bones are separated. Doctors do not know half the ignorant things which are done when their backs are turned.

I hope, after my description of the skull and all it contains, you will be careful and never strike each other on the head. A hard blow on the top of the head may take away both your memory and your sight. People have often been blinded by such a blow. A severe box on the ears may make you deaf all the rest of your life. My youngest brother, many years ago, tried to defend a poor woman who was being struck by her husband. The blow that was aimed at the wife fell on my brother's ear, and to this day his hearing has not been perfectly restored.

Remember it is equally cruel to strike dumb animals on the head; I constantly see horses, donkeys, and all cattle struck on the head by their masters, who want to make the poor tired animals go faster. This is not the way to increase their speed, for the blow only stuns and stupefies them, so that they neither know where they are going nor what they are doing.

*Things provided for the Lecture.*

A human skull.
Marshall's diagram of the skeleton.
A picture of the deformed head of an American Indian, and a picture of a naturally-formed head.

*Questions for the Third Lecture.*

1. Why do dumb animals require as much fresh air as human beings?
2. Tell me some of the reasons why butcher's meat is very dear.
3. What does the skull contain?
4. Why is it very dangerous to press the bones of a new-born infant's head together?
5. Why is it very cruel and dangerous to strike a human being or a dumb animal over the head?

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## LECTURE IV.

### *SKELETON—JOINTS AND MUSCLES.*

To-day I am going to finish my account of the skeleton. I have still something more to say about the skull. Under this bony covering there is a tough membrane;[1] beneath this is a very thin, smooth, moist membrane, and underneath this is the brain, which is itself closely covered by a third membrane, chiefly composed of blood-vessels. The skull is covered by the skin, on which the hair grows; under this are muscles and tendons, and under these is a membrane which is closely connected with the bones. I am very anxious you should understand and remember that the bones of the head and their coverings afford a very good protection to the brain, because some mothers and nurses who have unfortunately never been taught physiology say that it is dangerous to wash a baby's head, because, if you do, the water will certainly run through into the brain, and give the child the disease called water on the brain. You will now understand

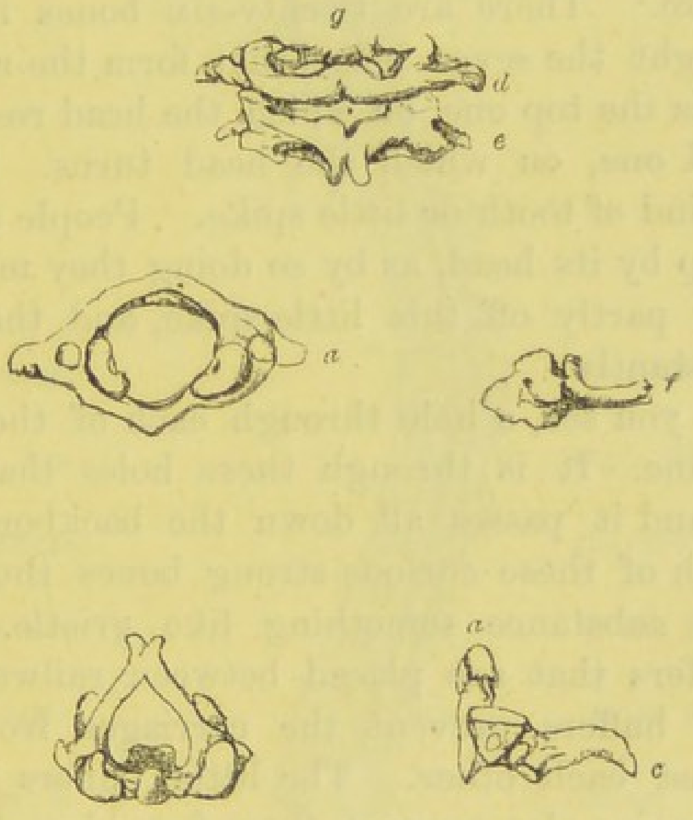
[1] A membrane is a kind of skin.

that it would be quite impossible that such a thing should happen.

In Poland there is a dreadful disease called 'plica Polonica,' which is generally caused by allowing the head to be very dirty. The hair becomes matted together and sticky and grows to a great length.

A baby's head requires to be washed with soap and water more than any other part of its body. I will tell you the reason why. You know there is a great deal of oily

FIG. 8.




*a* is the first bone or vertebra in the spine. It is a smooth ring, and is fastened to the bottom of the skull just round the hole through which the spinal cord comes out; *f* is a side view of this vertebra. *b* is the second vertebra; it has a curious piece of bone that stands up in the front: you can see it in *c* marked *a*. *c* is the same bone seen from the side. We can turn our head both to the right side and to the left, because the top ring can move about on the second ring, and the piece of bone that stands up keeps the head in its place. It is very dangerous to lift a child up from the ground by its head, for the top ring might be pulled off the tooth, and then a child or man would instantly die. *d* and *e* are the two first bones I have described placed one upon the other. *g* is the piece of bone coming through the top ring.

matter in our hair, and a great deal of this oily matter comes out, to nourish it, from the pores in the skin of the head. As we wear no covering to our heads unless we are out of doors, the dirt and dust in the air mix with the oily matter and form a kind of black paste. A baby's head requires to be kept cool; for that reason it has generally no hair. The sweat carries off the heat through the pores; but if all the pores are shut up, the sweat cannot get out, and the child's head grows hot and feverish.

In England, Wales, and on the Continent, particularly in Italy and France, I have very often seen children with perfectly black heads. By trying to remove this dirt when they get older, the mothers frequently give their children very sore heads. Now, if plenty of soap and water had been used from the first day, all this suffering would have been saved.

The head rests on the spine, or backbone, which you see in this picture.[1] There are twenty-six bones in the spine. I have brought the seven bones that form the neck to show you. This is the top one, on which the head rests, and here is the second one, on which the head turns. This second bone has a kind of tooth or little spike. People should never lift a child up by its head, as by so doing they might perhaps lift the head partly off this little spike, and then the child would die instantly.

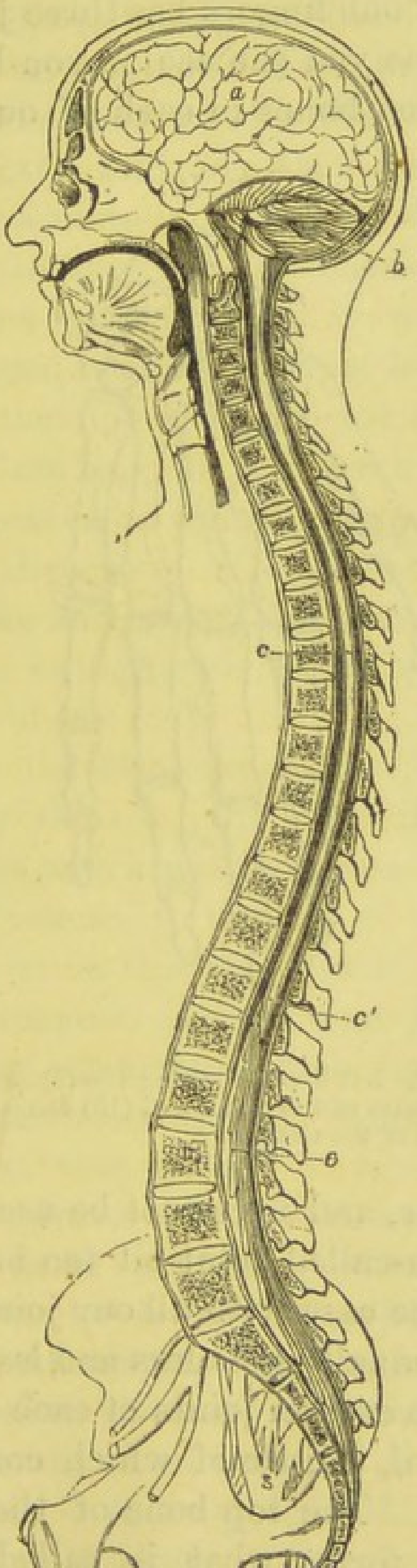
There is, you see, a hole through each of the bones that form the spine. It is through these holes that the spinal cord goes, and it passes all down the backbone, or spine. Between each of these curious strong bones there is a little cushion of a substance something like gristle. You have seen the buffers that are placed between railway carriages. The railway buffers prevent the carriages from knocking hardly against each other. The little buffers between the bones of the spine also prevent them from knocking against each other and from shaking the spinal cord, which passes down from the brain. It is such a very delicate substance that even a violent shake has been known to injure it for life. You see there are twelve ribs on each side of the spine; they begin below the neck, which is made of these seven bones, and, together with the narrow flat bone in front of the chest, called the sternum, cover the heart and the two lungs. All this part of the body is called the trunk.[2]

I will describe what a joint is. A joint is the place where two bones join together. On the left side of the figure of the skeleton you see that the bones are all fastened together by

[1] Marshall's diagram, p. 27, fig. 9. [2] Marshall's diagram, No. 1, p. 20.

strong bands, called ligaments. Usually the end of a bone which forms a joint with another bone is covered over with a

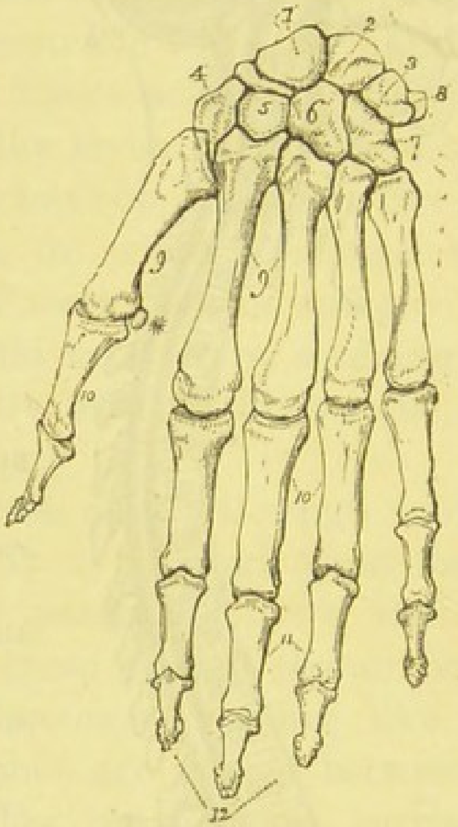
Fig. 9.




Half the skull and backbone, to show how safely guarded both the brain and spinal cord are by their bony coverings. *a*, big brain; *b*, little brain; *c*, the spinal cord. This picture shows the different bones of the spine, and how it is curved to make it very strong.

piece of gristle, called cartilage, and in those joints which we can move there is a bag between the two bones which contains a fluid like the white of an egg, improperly called joint-oil. This joint-oil makes the movement between the bones more easy. Each of our fingers has three joints. The thumb has only two joints, as you can see, if you look at your hands. We have twenty-seven bones in each of our hands. When a

FIG. 10.



Back view of the bones of the left hand, showing the (8) small bones next to the wrist joint, (9) the bones of the palm of the hand, and (10) the bones of the fingers, and the distinct porti on and length of the thumb.

person breaks a finger, and it cannot be used for some time, it becomes stiff; the so-called joint-oil too has almost all gone away. And this is the case with all our joints; if they are not used the joint-oil gradually gets less and less, and they become stiff. Now, between certain joints of each of the bones of the spine there is joint-oil, a little of which comes out every time we move our backs. The top bone of the arm fits into the shoulder-blade, and forms what is called the cup-and-ball joint. There is a good deal of joint-oil in the bag that covers the top of these bones. It is easy to pull the ball out of the cup, and this accident often happens to little children. It is called dislocation. The ball is kept in the cup by bands of tough membrane called ligament, that pass from the shoulder-blade to the arm. These bands are soft and flexible, and so they enable us to move our arms freely, as in skipping or turning the handle of a grinding-machine.

Nurses ought to be very careful not to drag children along by one arm, or hold them up by their arms, as they frequently do. A doctor told me that he has often stopped his carriage to beg a nurse not to drag the child by its arm. His trouble was all in vain, for the nurse, he said, evidently thought that he knew nothing about it; and did not attend to him. He saw his own nurse swinging his little girl by her arm, and told her that by doing so she might put it out of joint. This did at last happen. When his family were away at the sea-side he received a telegram from his wife to beg he would come to her directly. When he arrived he found that the accident which he had often foreseen had at last happened. The nurse had been swinging the child by its arms, and had pulled the ball out of the cup.

Let us next take the hip-joint. This joint is just like the cup-and-ball joint in the arm; the only difference is that there is a strong ligament which passes across from the ball of the thigh-bone and is fastened to the cup of the hip-bone. This joint is plainly shown in this diagram of the skeleton.[1] The thigh-bone is the longest, largest, and heaviest bone in the body. The bands or ligaments which bind the bones of the hip together are immensely strong, because all the weight of our trunk rests upon this joint. It is very difficult to cure any disease of the hip, as it is not allowed any time to heal, because we cannot move our bodies without moving the hip. It is very sad to see so many little children in our Leeds Infirmary who are suffering from hip complaints, and they do suffer most dreadfully. Doctors say children often get hip complaints from sitting on cold stones or damp grass, so that you must take care not to let your little brothers and sisters sit on anything damp or cold.

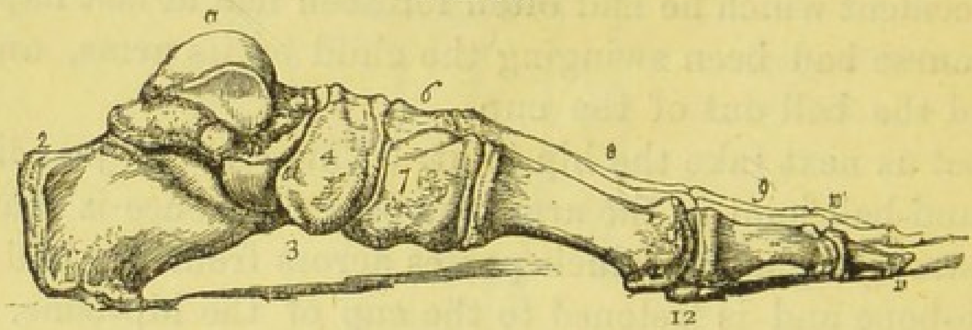
I shall never forget going to the Leeds Infirmary once, when I saw a boy of about twelve who was suffering from a

[1] Marshall's diagram, No. 1, page 20.

hip complaint. I went up to him and asked him what had caused it. He told me that one day, when he was playing at marbles in the streets, a big boy came up and wanted to tease the little boys and take their marbles from them. At last they quarrelled, and a number of lads took this boy by his arms and legs, and dragged him over the road. When he tried to get up and walk home he found he could not move. After suffering a long time at home he was taken by his father to the Infirmary, and then the doctors found his hip-joint was injured, his spine hurt, and his ankle-joints had been twisted. No boy, I am sure, would have been so cruel as to do this if he had only understood the dreadful sufferings his thoughtless conduct might cause.

In diseases of the hip-joint people cannot bear the slightest shake. I had a dear little friend who died from a

Fig. 11.



Side view of the bones of the left foot, showing the projection of the heel at 2, the arch which the bones make at 3; the strength of the bones of the great toe (9, 10, 11, 12); *a* is where the leg-bone joins the ankle. In the ankle, as in the wrist of the hand, there are several bones.

complaint in the hip. If anyone walked across the room in the very gentlest manner, she was thrown into an agony of pain. Mr. Wheelhouse told me it was no wonder she suffered so dreadfully, because the top of the ball, which is covered in health with a very soft covering, had come away and left the hard bone to scratch against the cup, in which there was an abscess. Nurses who don't understand about the hip-joint often scold children for crying when they are moved.

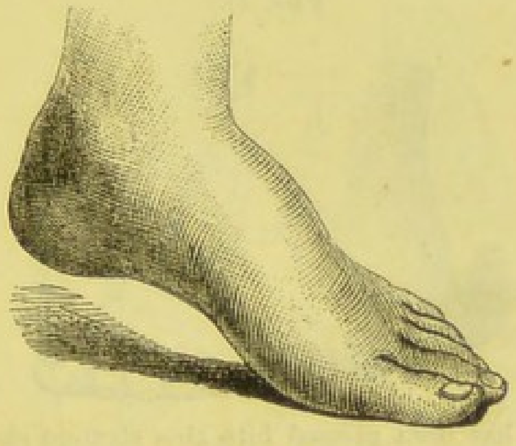
The knee-joint [1] has a little bone that is placed over the front of it; it is called the knee-cap: it guards the knee-joint. Little children constantly fall, and they would often be hurt if the little cushion which there is on the front of

[1] Marshall's diagram, No. 1, page 20.

this knee-cap did not save them when they fall. In women who kneel to scrub floors or stone steps this little cushion often becomes very much inflamed. They ought to get a towel or some straw, and make it round, so that a hole is left in the middle for the knee-cap to drop into.

I must now tell you how wonderfully our feet are made. There are a great number of bones and joints in the foot. The feet have to bear all the weight of our bodies. Very often you will see dancers stand on one foot, or even on the tips of their longest toes. The foot is made in the form of an arch, because,

Fig. 12.



Natural foot.

as I told you, an arch is the strongest form we can make. I hope you will never wear tight boots nor high heels, but those which have good broad soles ; and take care the soles are thick. I dare say you have often heard your mothers say to one of your little brothers, 'Now stand like a man.' It is a fact that no animal can stand erect upon its feet like a man. The ourang-outang can stand upright nearly, but it always stands on the outer edge of its feet, supporting itself in walking and running with its long arms touching the ground. Shoes ought to be made very wide at the bottom, so that we can stand firmly in them, and have plenty of room to move our joints about. The Chinese think it very vulgar for ladies to be useful and have natural-sized feet, so they bind a baby's feet, if it is a girl, with strong bands, to prevent it from growing. When they grow up, these poor ladies are scarcely able to move about.

I must now describe the muscles. You see these bundles of flesh in this drawing;[1] they seem to be plaited over the bone of the arm. Each of these bundles of muscles contains perhaps three hundred little fibres, or threads, of flesh. When I use my arm I sometimes wish to stretch it out and make it long, and then I want to pull it up and make it short. The reason why I can do this is because all these little threads of flesh are both elastic and able to contract; that is, they can stretch out and go together again, like this piece of india-rubber. We all ought to know how to make these muscles strong and firm, because, unless they are strong, we can do no work. There is only one way of making them strong, and

Fig. 13.

Chinese foot, that has been pressed into this strange shape by bandages when the child was an infant.

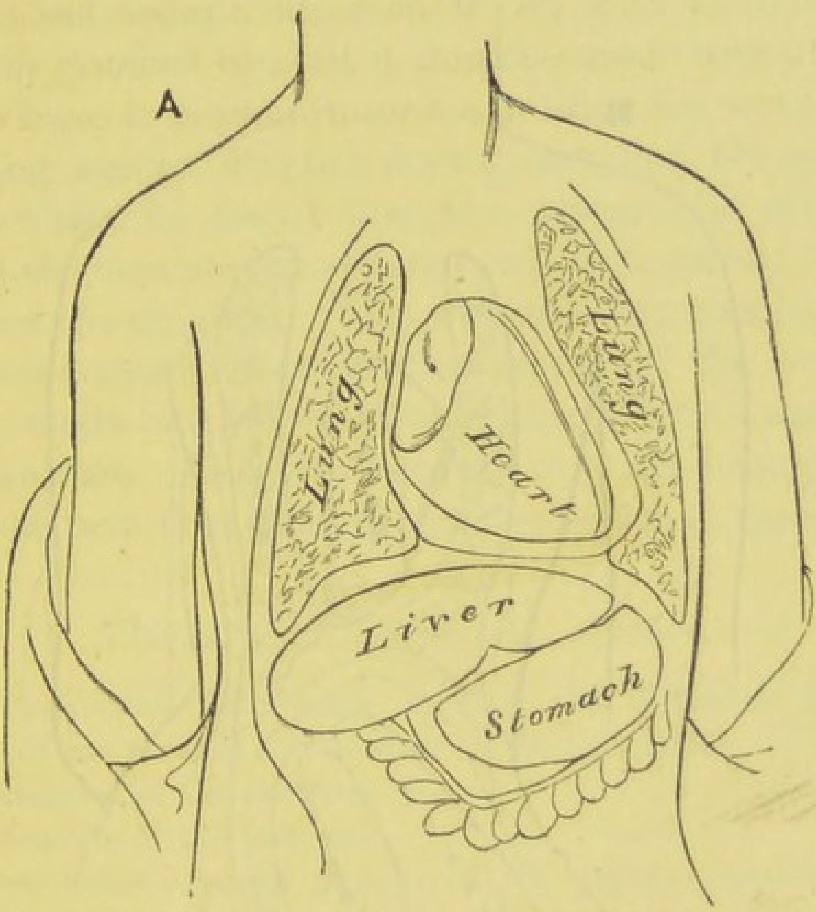
that is by using them. You have all seen a blacksmith working in his shop. A blacksmith has to use his arms a great deal when he hammers out the hot iron. No man has stronger muscles in his arm than the blacksmith. Just ask one to let you feel his arm, and you will find that he can make it nearly as hard as the iron he hammers all day. In countries where there are no telegraph wires men carry the messages and run great distances, and the consequence is the muscles of their legs grow very strong. There is a very strong muscle that passes down the back part of the spine, and others which go down the front part of it. They keep all the twenty-six bones of the spine together, and they enable us to bend up and down, because they can stretch and go together again. If we don't use these muscles, our spines grow weak. When these muscles and ligaments are weak, or very often in conse-

[1] Marshall's diagram, No. 4, page 40, letter M.

quence of a fall, the bones get out of their places, the spine becomes weak, and the back curved and twisted. In other cases, the bones become diseased, and then the back becomes bent or 'humped.'

I dare say you have heard of a country called Greece. About two thousand years ago the Greek people were the

Fig. 14.

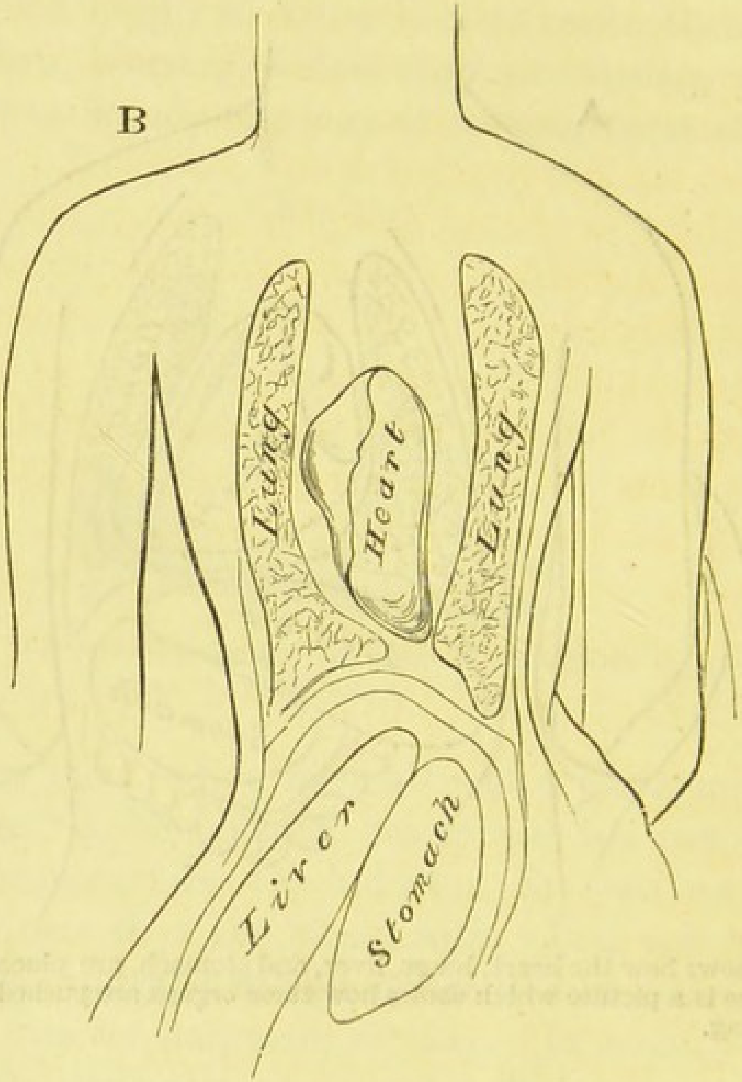



This picture shows how the heart, lungs, liver, and stomach, are placed in the body. On the next page is a picture which shows how these organs are pushed out of their places by tight lacing.

handsomest and cleverest people in the world; they made all the boys and girls learn a great deal, but they also made them run, walk, and play a great deal, because they said it was quite impossible to have a healthy mind if the body was weak. Perhaps you have been to what is called a gymnasium, a place where people jump and do all kinds of wonderful things. We have no doubt learnt how to perform many wonderful feats by reading Greek books that told us how to do them.

Boys are much better off than girls, for they play at some good game every day, either cricket or foot-ball. Girls have just the same muscles as boys, which can only be made strong by constant use, and yet they are scarcely ever allowed to exercise them. The consequence is that women more frequently have spinal complaints than men, which make them helpless and causes them great suffering. Not only are girls

Fig. 15.




The organs pushed out of their places by tight lacing.

made to sit for hours every day in one position, at school or when sewing, without any rest to their spines, but they are made to wear stays, which prevent their muscles from moving about. Grecian women had beautiful figures, but they were not allowed to wear such barbarous things as stays. Their dresses were loose, and consequently very elegant. Here is a picture of a person who has worn tight stays (Madame Bodichon's drawing enlarged). You see the heart and lungs, and other organs, are completely pushed out of their places. A great many tailors and dressmakers die of consumption because they have to sit still so many hours, stooping over their work in bad air. I trust tailors will soon become too intelligent to think it is necessary they should sit on a board with their legs crossed and their backs bent. While going over a public institution the other day I was extremely sorry to see a master teaching little boys of ten and upwards to sit in this way. It is bad enough for men to sit with their lungs and other organs crushed up, but it must be much worse for growing lads to have to remain in such a position for several hours.

Not long ago an English doctor travelled through a part of Africa where he found that the women did all the hard work, and the men stayed at home and took care of the houses and minded the children. The women's muscles had become by this means much stronger than those of the men. This experience made him believe that women after all are not born weaker than men. It is only because they are brought up less sensibly than men that their frames are so much more delicate.

### *Things provided for the Lecture.*

A piece of whalebone and elastic to show the difference between the stretching of the muscles and *bending* of the ligaments.

Marshall's diagram of the skeleton.

Marshall's diagram of the muscles.

Madame Bodichon's enlarged picture of the organs distorted by tight stays, and her picture of them in their natural state.

A picture of a Chinese foot altered by having been bound up.

A picture of a well-formed foot from nature.

Vertebræ of the neck, with a thick skein of white wool run through the holes to represent the spinal cord.

### *Questions for the Fourth Lecture.*

1. How many coverings are there to the brain?
2. Why is it more necessary to wash an infant's head with soap than any other part of its body?
3. Why is it dangerous to swing a child round by its arms?
4. What must we do to make our muscles strong? Why do more girls suffer from spinal complaints than boys?

## LECTURE V.

### *THE CIRCULATION.*

BEFORE I begin to describe the circulation of the blood I should like you to understand what an organ is. No doubt you have often heard people speak of the organs of the body. An organ is an instrument which does something.

The organ of the body I am going to tell you about to-day is the heart.[1] I have brought you the same beautiful model of one which I had at my first lecture. This wonderful little organ, or instrument, has to do a very great deal of hard work, as you will think, I am sure, when I tell you that it sends blood to every part of our body in about half a minute. We have at least forty organs, or places, in the body where something is done, and the active part of each of these forty organs ought to be entirely re-made in about forty days.

The forty different organs are made of different substances. Our blood also contains at least forty different substances. I have in these bottles some of those substances. I have chosen a few whose names you will all know—salt, soda, fat and other substances rich in sugar, iron, lime, phosphorus, albumen, and carbon. Perhaps you have never heard before the name of the last substance. I shall have a great deal to tell you about carbon in all my lectures. Charcoal is almost pure carbon. I have written on this sheet that coal, fat, sugar, starch, all contain a great quantity of carbon. The purest carbon is the diamond. The ring I have on my finger is made of pure carbon, because it is a diamond. If I were to put my ring into a very hot furnace indeed, it would burn as a piece of coal or fat will. It is mixed with no other substance; and for that reason it is called an element, which means that it is made of only one thing. Carbonic acid gas sounds a little like carbon, but they are very different things, as you will soon learn.

Our bones are surrounded by two things—flesh and fat.

[1] Here I showed Auzoux's model.

Now, flesh and fat are entirely different substances, and this I hope to make you clearly understand before I finish my lectures. You see I have three bottles all standing in a row together. They contain lime, gelatine, and phosphorus. Here is a common match, that has some phosphorus at the end of it. Gelatine, which is glue, is made from bones by boiling them. Lime you often see your mothers use when they whitewash the walls or ceilings of your houses. Our bones are made almost entirely of these three things. All the 206 bones in the body ought to be firm and strong when a child is seven years old; but if a child has not been fed on food that contains the three things I have just mentioned—lime, phosphorus, and gelatine—its bones will not be firm, and it will grow up a poor miserable little ricketty creature: its legs will be crooked; its little frame will be too weak to support the flesh; the bones in the spine will give way, and it will be deformed. You have all seen poor little men and women with big heads and small bodies. They are called dwarfs. A lady in Leeds not long ago counted the number of cripples, dwarfs, and ricketty children who passed by her house as they were coming from the mills. I dare not say how many she counted.

It is no use to buy lime, gelatine, and phosphorus in a druggist's shop; these three things must be in the food we eat, or else they will not make bone. There is only one kind of food that contains these three things, and all the many substances that the blood requires. It is milk.

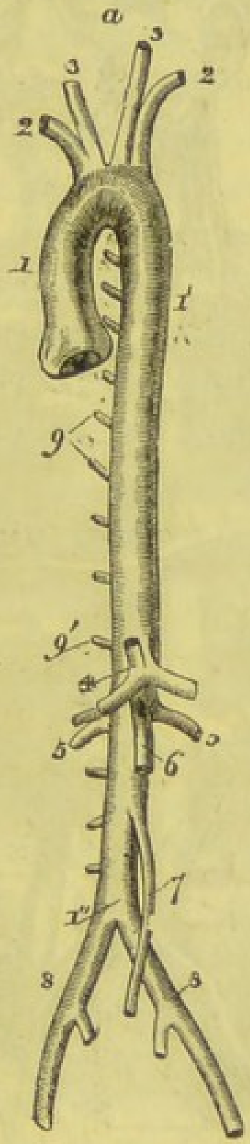
Here is the blade-bone robbed of its earthy matters, that is, of its lime and phosphorus, by soaking it in an acid, so that it appears somewhat as it would be if a child had not been fed on milk. You see it is quite soft. I can bend it any way, because it only contains the animal matter which gives us in boiling the gelatine, no lime nor phosphorus. It is said that for every rich man's child that dies poor men lose three, because their wives go out to work, or to nurse those rich men's children, and do not give their own babies the milk God intended they should have.

I will now describe the circulation of the blood. When anything circulates it must set off from a certain spot, and it must return to that same spot again. Now I will prove that all our blood leaves a spot, the bottom part of the left side of the heart, and returns to exactly the same spot after it has nourished nearly every part of our bodies; therefore it will have circulated. I wish to tell you that the heart can do this wonderful work in about three minutes. The heart of a man is about the size of his fist; the heart of a baby is also the size of its fist. Our hearts, which are made chiefly of contractile flesh or muscles, are divided down the middle by a strong wall of flesh; the good clean blood is all kept on the left side; all the dirty blood is on the right side. Some big tubes, called arteries, carry all the good blood from the left side of the heart to every part of the body. I have written the word artery on this sheet, and painted it a bright red, because the good blood is a bright red, as it contains a great deal of oxygen gas. The arteries are very strong tubes; they have three coats. In the outer coat there are some elastic fibres which permit the artery to stretch out lengthways. The coat underneath this has muscles which go round the arteries, and make them come together or contract. By this means the arteries keep stretching out and pulling in, and so force the blood on, so that it flies about to every part very fast. There is a third coat inside those I have described; it is beautifully smooth, so that the blood may easily pass over it.

I will now point out to you the large arteries in the lower part of the body. There are thousands and thousands of little arteries which spread out from the larger arteries to every spot of the body. Though the good blood flies along so quickly, it finds time to feed the forty organs with fresh stuff, and also to carry away the parts of the organs that have become worn out. I will tell you how this is done in the next lecture. Don't you think it is very wonderful? Of course the blood at last becomes very dirty. Dirty blood would not feed the organs; it would only make them unhealthy and diseased. How is the dirty blood to be carried away and made clean?

I will tell you how it is managed. Every artery has a servant that carries away the dirty blood up to the right side of the heart, through which all the dirty blood is sent on to the lungs. This servant is called a vein. It is a strong pipe of membrane, but not so strong as an artery, though it has three skins. I told you that there were thousands of little arteries; there must also be thousands of little veins, because every artery must have a vein fastened to the end of it in a very peculiar way, to carry away the dirty blood. All the

FIG. 16.

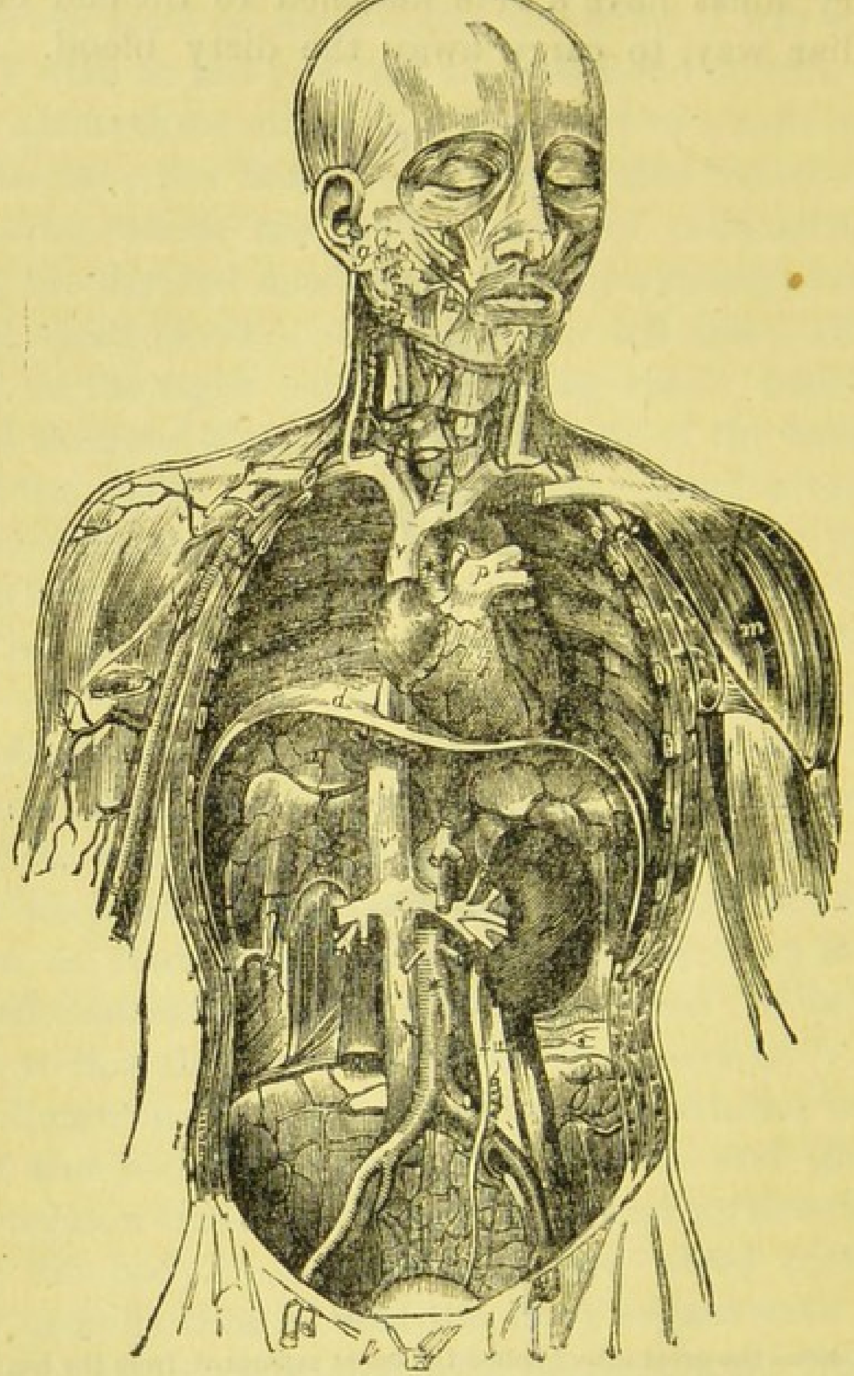



This diagram shows the great artery called the *aorta* separated from the heart. 1 is the part of the artery that is fastened to the left side of the heart, where all the good blood is held. 2 and 2 are the arteries that carry the good blood into the arms; 3 and 3, those that carry the blood into the head; 4, artery which divides into three branches to feed the stomach, liver, and spleen; 5, arteries that go to the kidneys; 8 8, arteries that carry the good blood into the lower parts of the body and legs.

veins in the body join together and make two big veins. They are to be seen in this picture (fig. 18, page 42, marked 1).[1] This upper vein, called the superior or upper vena cava, brings all the dirty blood from the head and upper limbs, and this other below it, marked 2, called the inferior or lower vena

[1] Marshall's diagram, fig. 16.

Fig. 17.

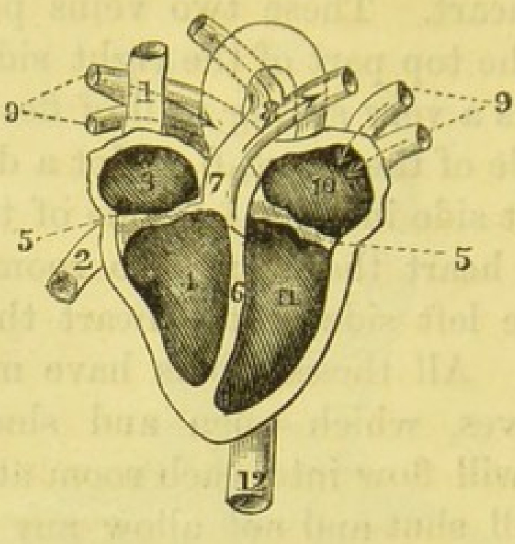


View of the chest (or thorax) and the abdomen. The front part of the diaphragm has been cut away to show the organs in the abdomen. The lungs have been taken away from the chest; only the heart *h* is left; the bag (or pericardium) which holds the heart has also been removed. The heart is held by some large blood-vessels—namely, *p*, the pulmonary artery, that takes the *bad* blood into the lungs to be cleaned; *a*, the great artery called the aorta, that carries the good blood to all parts of the body from the left side of the heart; *c*, the great vein (superior or upper vena cava) that brings all the dirty blood into the top room of the right side of the heart from the upper parts of the body, and the other vein (inferior or lower vena cava), marked *v*, which brings all the dirty blood fro n the organs in the abdomen and the lower parts of the body also up into the top room of the right side of the heart. This vein is seen going through the diaphragm marked *d*. The left kidney (right in the picture) *n*, is seen in its natural position with its arteries and veins going into and out of it. The pipe or duct *u*, which carries the water from the kidney to the bladder, can be seen fastened to the bladder, which lies nearly concealed in the pelvis. The right kidney has been taken away; it has also a pipe like the left kidney. I, the bladder, *m*, muscles.

cava, is carrying all the dirty blood from the lower part of the body up to the heart. These two veins pour all the black dirty blood into the top part of the right side of the heart, 3. Remember there is a very strong wall of flesh that goes down through the middle of the heart, 6. Not a drop of blood can run from the right side into the left side of the heart. In the right side of the heart there are two rooms or chambers, 2 and 3, and in the left side of the heart there are also two rooms, 10 and 11. All these rooms have most curious little doors, called valves, which open and shut. About three ounces of blood will flow into each room at a time, and then the little door will shut and not allow any more to pass in. We will now suppose that three ounces of dirty blood enter into the top room on the right side. When the door from the vein is shut behind it, the blood will flow through the other door, which will close in the same way. Directly the three ounces of blood get into the bottom room the wonderful little heart will pump it all through particular pipes, called pulmonary arteries, into the lungs, where it is made clean and of a beautiful bright red colour by the oxygen which the lungs ought to contain. The clean blood will then be carried by other pipes called pulmonary veins, to the top room on the left side of the heart. Three ounces will flow through the top door, which will then shut; the blood will then pass through the second door, which will then instantly close. Directly it reaches the bottom room the heart will pump it into this large red artery, called the aorta (p. 39), which will carry it by many branches to every part of the body. You see I have now brought the clean blood back to exactly the same spot it set off from; therefore it has circulated over every part of the body. I will show you the four rooms and the doors, or valves, in this model when the lecture is over.

Before I conclude my lecture I will explain why it is that we hear our hearts beat. You see the heart comes to a point at the lowest part, where the two rooms are placed which pump up the blood. Now, the heart in pumping out the blood from these two rooms forces this pointed part against the ribs, and so makes that sound or noise which we call the beating of the heart.

FIG. 18.




View of the heart with its several chambers exposed, and the large blood-vessels that either carry away the blood from these chambers or bring blood into them. 1, superior or upper vena cava; 2, inferior or lower vena cava; 3, the upper chamber called the right auricle; 4, the lower chamber called the right ventricle; 5, the line marking the separation between the two chambers; 6, the wall of flesh that separates the two sides of the heart, called the septum; 7, the pipe which carries away the dirty blood from the lower chamber, on the right side marked 4, into the lungs, and is therefore called the pulmonary *artery*; at 8, the artery divides and sends one branch into the right lung and the other into the left lung; 9, the four pipes called pulmonary *veins*, because they bring the good blood *back* into the heart and into the upper chamber marked 10; 12, the great *artery* called the aorta which carries away the good blood to feed every part of the body, from the left lower chamber, marked 11.

## *Things provided for the Lecture.*

Marshall's diagram showing the circulation.
Auzoux's papier-mâché model of the heart.
Bottles of some of the forty substances contained in the blood.
A sheet with all the difficult words used during the lecture.
A blade-bone deprived by means of an acid of its earthy matter, and one properly nourished.

## *Questions for the Fifth Lecture.*

1. What is an organ?
2. About how many different things does our blood contain? What is the name of the only food that contains the substances necessary to feed the blood?
3. Name the three things that almost entirely make our bones?
4. What are the names of the pipes that carry our good blood?
5. What are the pipes that carry our bad blood?
6. Describe the heart and all you can remember about the circulation.

## LECTURE VI.

### *THE CIRCULATION* (*continued*).

I ONLY described to you in my last lecture how the blood circulates through the body, or trunk, and the lower limbs. I must now tell you how it circulates through the head and arms.

I will first point out the large arteries that take the blood up to the head. Of course, close by their side will be the veins, their servants, as I have called them, to carry away the bad blood. You all know how many precious organs the skull contains—the organs of sight, hearing, taste, and smell. We must not forget the brain, which gives us the power of thinking and doing what we wish to do. All these organs require a great deal of good blood. Directly the heart cannot pump up blood into the head the brain stops working, and then we lose our senses, faint away, and cannot remember anything.

When the good blood is pumped from the bottom chamber of the left side of the heart some part goes up into the arteries that branch off into the arms and head and neck, whilst the other part goes into the trunk and lower limbs. After it has nourished the different organs in the head the veins carry away the dirty blood, and bring it all back into this large vein that is on the right side of the heart. Then, as you will remember, three ounces of it will flow through into the top chamber, or room, of the right side of the heart. Then it will pass through the little door, or valve, into the bottom room, from which it will be pumped into the lungs, where it will be made clean, and the colour will become a bright red. The blood will then be taken by arteries into the top room of the left side, where the good blood is kept, flow through the little door into the bottom chamber, where it will be squeezed or pumped out into the big artery called the 'aorta,' when it will fly along to every part of the body at a tremendous rate. This wonderful little organ will keep on working day and night. Should it cease its work for one minute we should die.

I said I would tell you in this lecture where the blood runs out of the blood-vessels to feed the body and all the organs (every pipe that carries blood is called a blood-vessel). You will be astonished to hear that not a drop of blood can pass through the walls or skin of either an artery or a vein. There are most wonderful little pipes called capillaries: they come between every small artery and vein and join them together by a sort of network of pipes. It is through the sides of these small pipes that the blood runs out to feed the body and all the organs. The capillaries have only one skin, and are finer than a single hair of our head.

You see these two glass pipes which are intended to represent an artery and a vein, and between them there is a small twisted pipe. Now, it is the twisted pipe which represents a single capillary, through the coat of which the blood escapes. Though these little capillaries are very often much twisted about, there is always a passage or road through them, so that the blood from an artery can run through them to a vein. I will now pour into the artery what we will suppose to be pure blood. You see that the blood continues a beautiful bright red until it comes to the vein, when it becomes a dark bluish-black colour: the reason of this is that the oxygen gas and some of the good blood have run through the walls of the capillary into the flesh to feed the body and organs, and the dirty blood, which is full of carbonic acid gas and worn-out stuff of the body, has come into the capillary and passed up into the vein. Certain materials in the good blood and the bad blood have changed places, because the good blood was light and the bad blood was heavy. A capillary won't allow two things that have the same weight to exchange places with each other through its skin. I will now show you a little experiment to illustrate this. Here is a pipe filled with some water that has sugar and a little red colouring matter in it. This end of the pipe is covered over with the same kind of skin that a capillary is made of. When I hold this end down no water runs through the skin. I will now put the pipe into this tumbler of clear water that has no sugar in it; therefore the water in the tumbler will not weigh so heavy as the water in the pipe, because there is sugar in the pipe-water, and for that reason the capillary skin will allow the heavy sugar-and-water to run through into the tumbler, and the clear water to pass up into the pipe. I should like a little boy or girl to come up and taste the tumbler-water before I put the pipe in, just to be sure that there is no sugar in the tumbler. We shall soon see whether any of the pipe-water has run through the skin, because it is red and will make the tumbler-water red. This other pipe contains some sugar-and-water, and there is also sugar-and-water in this tumbler; you will find neither of them will change places. A heavy gas and a light gas will change places with each other through the skin of a capillary. This balloon, which is made of the same kind of skin as a capillary, is filled with the heaviest gas—carbonic acid gas. In a short time you will see that the balloon will become nearly empty, because the carbonic acid gas will have passed through the skin into the air in the room, and the air in the room, which is light, will have entered the balloon.

As it is only through the coat of the capillaries that the blood can pass out to feed the body, it is necessary that we should have an immense number of them, and they must be in every spot in our bodies. Directly the blood gets hot these little tubes grow bigger and swell with the heat of the blood, and so do the little arteries and veins between which they are placed.

I will now explain to you why our faces grow red—that is, why we blush. When we are ashamed or angry our faces grow hot. Then all these little pipes swell and more blood than usual runs through them into the flesh and skin, and so makes our faces appear very red. When we are frightened we grow cold. Cold makes nearly everything become smaller; and all these little tubes, whether veins, arteries, or capillaries, grow smaller, very little blood can get into them and run through the flesh and skin, and our faces must naturally grow white, because there is scarcely any blood to be seen through the skin.

It is much more dangerous to cut an artery than a vein, for you see that the blood pours from the heart into the arteries. If an artery was cut and you could not stop it, all the blood in the body would soon be drawn out. A string should immediately be tied very tightly above the cut in this way, that is, nearer to the heart,[1] to prevent the blood escaping through the cut.

[1] Showed a red leather pipe with a cut in it and a black string tied above.

A man was once reaping in a field, and cut the large artery in his leg. The blood jumped out in jerks, so much at a time. Doctors can tell at once, by the way the blood is jerked out, that it is an artery, and not a vein, that is cut, for the blood passes much more slowly and evenly through the veins. Now, the other reapers in the field crowded round him and began to cry out for help, which unfortunately did not stop the bleeding. A girl ran up to him, took off her garter, and tied it tightly round the part above the cut in this way, and it very soon stopped the bleeding. She saved the man's life, as he would have died before a doctor could have reached him. Every man and woman ought to learn how to act in case of such an accident.

The blood in the veins runs more slowly than in the arteries, about one-half or one-third more slowly, for in the veins the blood has much wider channels to travel through than in the arteries. At certain distances there are little doors in the veins which shut directly a certain quantity of blood has passed through them, just as the door in a mouse-trap closes when a mouse has passed in. These little doors sometimes become weak, and will not shut and open as quickly as they ought to do, so that the blood collects in the veins. Veins in this state are called varicose veins; and washerwomen and men who, like them, have to stand a great deal, suffer very much from this complaint. These veins are placed near the skin. The arteries are placed much deeper down, to prevent their being injured. Large arteries are very near the bones in a kind of little gutter. The best thing to do when anyone has a complaint called varicose veins is to keep the limb up as much as possible, and to rub the blood up, and help it to get through the little doors on its way to the heart.

A maid-servant of ours had a very bad leg caused by these varicose veins. A doctor told me to let her wear some elastic stockings, that would keep the veins up, and she found they did her a great deal of good. In such cases you can see the veins with their black blood spreading out under the skin like the branches of a tree.

Now, it is very dangerous for a person with a weak heart —that is, when those little doors in the heart do not open and shut very perfectly—to run to catch a train, or to go quickly either up a hill or up a flight of stairs. The muscles which surround the veins move very quickly when we run, and they work the blood up towards the heart just as we do when we press the veins up with our hands. Blood then gets too quickly to the heart. The doors cannot open fast enough to let it pass through to the bottom rooms, where it is pumped into the lungs to be cleaned, and into the big artery to be carried all over the body.

For many hundred years doctors were trying to discover how the blood was carried over the body. It was generally thought, I believe, that the arteries only carried a spirit or air. About two hundred years ago a doctor named William Harvey discovered the circulation of the blood—that the arteries carried the good blood from the left side of the heart, and the veins brought back the dirty blood to the right side of the heart, and so on. But he did not know anything about the capillaries; he thought the blood ran out through the arteries and veins to feed the organs. In those times there were no magnifying glasses or microscopes which were powerful enough to enable him to see the capillaries, which you know are too fine to be seen by the naked eye. When Harvey had been dead several years, very powerful microscopes were invented, and Malpighi was then able, with their help, to see that at the end of every small artery there is a network of fine little pipes, or capillaries, as they are called, which is also united at the other end to a vein.

Quadrupeds, or four-footed animals, and birds, have hearts like ours; but in reptiles there are only three rooms in the heart, and in fishes only two. By means of a heart their blood is also carried through arteries, veins, and capillaries. The skin in a frog's foot is very transparent, and so thin and clear that you can see through it, and watch the blood flying through the capillaries that are twisted about. Blood looks white, not red, in them. Doctors often place the foot of a live frog under the microscope. Of course you could not see the circulation unless you looked through very powerful glasses. There is only one skin to a capillary, and therefore we can see through it. It would be impossible to see through an artery or a vein, because they have three skins.

I will now show you a model of the chest containing the two lungs, and the heart lying between them. I will point out the large artery called the aorta, and I will show you the two *large* veins that bring the dirty blood back to the left side of the heart, called the upper vena cava and the lower vena cava. This time I will open the heart, and let you see the doors or valves that lead into the bottom rooms.

*Things provided for the Lecture.*

Marshall's diagram showing the circulation.
Glass artery, vein, and capillary.
Auzoux's paper-mâché model of a heart.
A spirit lamp.

1. To show what is called osmosis, I had a small glass tube which contained pink-coloured water with some sugar in it, the top of the tube being covered with a thin membrane. This I first placed in a tumbler of water which also had sugar in it, with the top of the tube downwards: the liquids being of the same density, no exchange took place. I next placed it in a tumbler of clear water, when both sugar and colouring matter came through the skin which covered the top of the tube, and sweetened the water in the tumbler, whilst water also passed into the tube.
2. To show that an exchange takes place between gases of different densities I have a small balloon made of a thin membrane filled with carbonic acid gas. The gas escapes through the membrane and leaves the balloon with a small quantity of ordinary air.

To show how to stop an artery I tied a string above a cut that was made in a soft red leather tube.

A sheet with all difficult words written large for children to copy.

*Questions for the Sixth Lecture.*

1. As no blood can run through the coats or sides of an artery or vein, how does the blood get out to feed the body and the forty organs?
2. Why do our faces become very red when we are ashamed, or white when we are frightened?
3. If an artery was cut, how would you stop it from bleeding?
4. Why is it dangerous for people who have heart complaints to run to catch a train or to go quickly up a hill or up a flight of stairs?

# LECTURE VII.

## *RESPIRATION.*

I AM going to-day to explain how the heat in our bodies is made, and how the blood is cleaned in the lungs.

I told you that charcoal is nearly pure carbon, and that fat contains a large quantity of it. Here is some charcoal in this bottle; you see it is a black substance. I have a candle here; there is a great deal of fat all round the wick. The wick of a candle is only made of cotton. I will now turn some of the fat which is in the candle into carbon—a black substance. I must have heat first, or I could not make the candle change at all: nothing can be changed without heat. You must all of you remember this. The candle is now lighted and very hot, and I will hold a white plate over the top of it, and you will see that the plate will become very black. If I held it long enough all the candle would have burnt away, and I should have a great deal of this black substance. You will say that that black stuff is only smoke, the same that comes from all the chimneys in Leeds when coal is burnt; and so it is exactly the same substance as the smoke and the soot that sweeps come and carry away in large sacks when they have swept our chimneys. It is very wrong that so much carbon should be wasted, for it is not at all necessary. A careful engine-driver will not allow any smoke to come out of his chimney; he burns every bit of coal he puts on his fire. Watch and see the next engine that is passing by, and you will find that only steam, which is water turned into gas or vapour, not smoke, comes out of the chimney. What a pleasant town Leeds would be if we had no smoke! We should be more healthy, and also save our money as well as use less coal. Coal, it is said, is growing very scarce.

I have a spirit-lamp here. Pure spirit contains only a little carbon. You see the wick of this lamp is much larger than the wick of a candle. You will find when I light it, that the wick will not grow black like the wick of a candle, nor will the white plate become covered with smoke when I hold it over the lamp, because I have not been burning fat, but spirit, or alcohol.

When you burn anything I dare say you think the thing you have burnt is quite destroyed—that it is no longer to be found in the world—but you must never think that any more. God does not allow us either to destroy or to waste any of the matter that He has made. By burning we only change the thing we burn into something else. I have now burnt about an inch of this candle—that is, I have turned a great part of that inch of fat into this black stuff, and I have also made some carbonic acid gas. Carbon is very fond of oxygen gas. Directly they come together hot, they make a great deal more heat, and very often a flame of fire.

Here is a bottle of oxygen gas, and here is a piece of charcoal which is nearly all made of carbon. The charcoal is hot, you observe; I will put it into the oxygen, and you will see what a bright flame and what a great deal of heat is made. This candle has just a little spark of light on it. I will put it into this other bottle of oxygen, and it will also burst into a flame, and cause great heat. This bottle, you know, was full of oxygen a minute ago, and made the lighted candle burn so brightly; but the oxygen and carbon have joined together, and have made a new substance, carbonic acid gas. There is no free oxygen left. The bottle is now full of carbonic acid gas; this I will prove to you, for directly I put a lighted candle into it the light will go out. If a great many candles are burning in a room they will fill the air with carbonic acid gas, because the carbon in the candle will join with the oxygen that is in the air of the room and make carbonic acid gas. The flame of one candle will require as much oxygen as a man needs to keep his blood pure, and the candle will also make an equal quantity of carbonic acid gas. There is a great deal of carbon in gas. One gas-light will use as much oxygen as three men, and make three times as much carbonic acid gas. No wonder that people feel very sleepy and faint in theatres, workshops, and churches, which are crowded, badly ventilated, and lighted by gas or by a great many candles. In nurseries where children sleep, or in bedrooms—particularly where invalids are placed—gas ought not to be used, unless the room is large and very well ventilated.

Nearly all the heat there is in the world, and nearly all the heat we have in our bodies, is made by oxygen and carbon joining together. Our blood contains a great deal of carbon and an immense quantity of oxygen. I will now explain where the oxygen meets the carbon in our bodies, and how the blood is made clean and hot in the lungs.

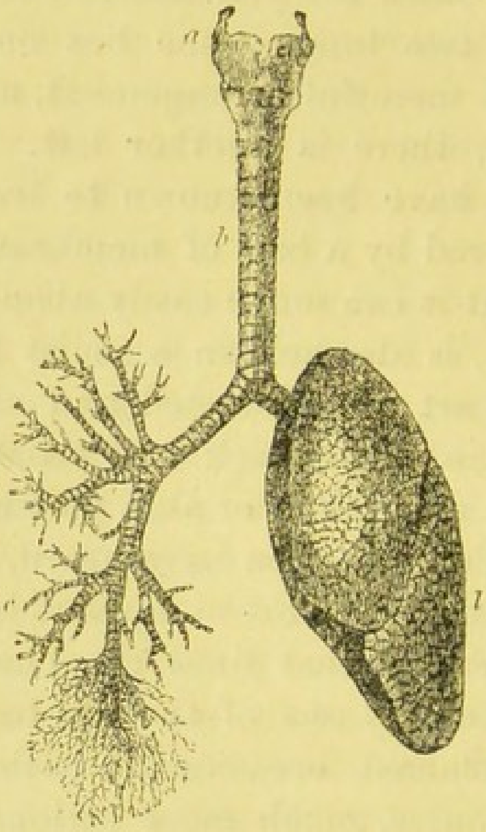
First of all I must tell you about the lungs and windpipe. We have two lungs; one lies on each side of the heart. This is a merciful arrangement, as, in case one lung becomes diseased, there is another left. People with only one healthy lung have been known to live for a long time. Each lung is covered by a bag of membrane, which is always kept moist, so that it can move easily about. The heart, that lies between them, is also held in a moist bag of membrane. The lungs and heart are protected and covered by the ribs and the breast-bone. The back and front of the chest are lined by the same membrane or skin which covers the lungs. It is called the 'pleura.' You have heard, perhaps, of a complaint called 'pleurisy.' This complaint is caused by an inflammation of the skin that lines the chest and covers the lungs. Sometimes only one of the two bags which hold the lungs becomes inflamed, occasionally both. When both are affected it is, of course, much more serious. The two lungs are quite separated from each other.

Next I must describe the windpipe. By the word windpipe I mean the pipe that leads down from the mouth into the lungs. The windpipe is wonderfully made. Here is a picture of it.[1] There are strong rings of gristle that nearly go round the pipe; they are fastened to a band composed of flesh that runs down the back of the windpipe. If there were not these firm little rings to keep the windpipe stretched out, the sides of the pipe might fall together, and then no air could get into the lungs. A windpipe is a very good name for this tube, for it carries all the wind, or air, through the nose and mouth down into the lungs. When this curious pipe gets

[1] See diagram, page 52.

down some way, it divides into two tubes, one of which, called the right bronchus, goes into the right lung, and the other, called the left bronchus, into the left lung, and then from each of these thousands of little pipes, called bronchial tubes, branch out like the branches of a tree, only the branches gradually get smaller and smaller, until they become very fine, but not so fine as the hairs of our head. They end in

FIG. 19.




*a*, the larynx, the box where the voice is made; *b*, windpipe (or trachea). *l* is a lung in its natural state. On the other side is seen a lung, *c*, that has had the fleshy part (which is like a piece of sponge with thousands of little holes) taken away, so that the air-pipes, or bronchial tubes, which carry the air into the little holes, may be seen.

fine little pipes, to which are fastened little cells or air-bladders.[1] Each one of these air-bladders looks like a small white grape. There are, it is calculated, about six million little air-cells in the two lungs.

You have all seen a piece of honeycomb; I have a piece here. It is said that the lungs are very like a honeycomb. Now all round the outside of these air-cells there are very fine little pipes, the capillaries of the lungs, into which the dirty

[1] I here showed a fine glass pipe which had a glass ball at the end of it.

blood comes to be made pure. It is said that if all the little pipes, or capillaries, that are placed close together round the air-bladders were fastened together, they would reach across to America and back—five thousand miles. So you may fancy what an immense quantity of dirty blood can be put into them, though they are so fine and small.

I told you there was a great deal of carbon in the blood. Every time we take in a breath of good air oxygen flies down through our nose, and mouth too, if it is open, into the windpipe, and then into these little pipes (called bronchial tubes), and then enters into these little air-bubbles at the end of each tube. The air, especially the oxygen, gets through the coats of the air-bladders into the blood—that is, into the capillaries which lie all round the outside of the air-bladders. As this oxygen goes into the blood from the air-cells, carbonic acid gas passes from the blood into the air-cells: and so the blood is made pure and bright. When, again, this oxygen meets with carbonaceous matters in the blood or in the body, it and the carbon meet, join together and make a great deal of heat and vapour, but not a flame, or we should be burnt up. So that the oxygen that runs down our windpipe not only makes a great heat when it unites with the carbon of the blood, and of all the tissues of the body, by which the heat of the body is kept up, but it turns the dirty dark blood into a bright red colour, and makes it pure and clean. There is a great deal of oxygen in the arterial blood in the body. When this oxygen flies through the coats of the capillaries it meets with its dear friend carbon in every spot, for there is a great deal everywhere. They join together and make a great heat, and produce carbonic acid gas.

The heat in our bodies is almost always the same, summer and winter. The hands and feet and face are all much colder in winter than in summer; the blood gets colder just in those parts of the body which are not covered over with clothing. The cold air makes the capillaries very small, so that less blood can get into them. Doctors find out by this little instrument which I hold in my hand, called a thermometer, that the blood has always the same heat, summer and winter, if we are well—that is, about 98 degrees and a half. It is a little hotter in some parts of the body than in others. The word 'thermometer' means a measurer of heat. You see that there is a little glass pipe running down the middle of this thermometer. By the side of the pipe are dark lines, and each of the spaces between these lines is called a degree; and there are figures which mark the number of degrees. At the end of the pipe you see a little glass ball. It is full of a substance called mercury, which looks like silver. I have often told you that heat makes nearly everything grow bigger, and cold makes nearly everything smaller. Now, mercury is a substance which grows hot and cold very quickly. Let us see where the mercury now stands. It is, I see, opposite 60°. The air in this room is therefore sixty degrees. Now I will put the thermometer into boiling water, which is much hotter than this room, and you will see that the mercury grows so big that it will run up through the little pipe nearly to the top, and stay by a figure that is marked 212°; and you will see written opposite to that figure 'Boiling-point.' The mercury tells you how hot or how cold the air of a room is, or any substance we put it into; it tells us the water is at boiling-point. When we give anyone a hot-water bath, we always ought to have a thermometer and put it into the water to tell us the proper heat. If the mercury goes beyond the proper heat for a hot bath, it will be too hot. Children are often put into water a great deal too warm. They are not only nearly scalded, but very much weakened, by the great heat, all because the nurse trusted to finding out by her hand instead of using a thermometer. Some hands that are accustomed to be a great deal in hot water become so much hardened that they are quite unable to tell the heat that a bath ought to be. The doctors, when they want to find out the heat of the blood, don't put the thermometer on the hands or face, but they put the little ball filled with mercury under the tongue or on some part of the body which is well covered up, and where the cold air cannot get to chill the blood. It is most important you should understand about a thermometer, for unless you do you will not be able to understand when I tell you how to cook food.

*Things provided for the Lecture.*

A thermometer.
A candle.
A spirit lamp.
A white plate.
Diagram of windpipe.
Two bottles of oxygen gas.
Some pieces of charcoal.
A glass windpipe and bronchial tube with air-bubble.
Stodmann's model of the chest, page 59.
A piece of honeycomb.

*Questions for the Seventh Lecture.*

1. Why do people feel sleepy and faint who sit in a room where there are a great many candles or gaslights burning?
2. What is the name of the pipe that carries all the air we breathe into our lungs? Tell me all you can remember about it.
3. If all the blood-vessels or capillaries of the lungs were joined together, how far would they reach?
4. How is the blood made clean in the lungs?
5. What are the names of the two things that join together in our bodies and make our blood warm and give us all our heat?
6. How do doctors find out the heat of the body? What is the right way to find out the proper heat that a hot bath should be into which you are going to put a little child?

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## LECTURE VIII.

### *RESPIRATION* (*continued*).

You learnt from what I told you in my last lecture that our blood is the same heat both in summer and winter. It is a curious fact that, if we were even to breathe air as hot as boiling water, our blood would still be exactly the same heat.

Some years ago there was a man—Chabert—who was called the Fire King. He could go into an oven, the air of which was from 400° to 600°. He would stand in the oven five minutes, and it was found that when a thermometer was put under his tongue while he was in the oven, the heat of his blood was very nearly the same as when he entered it. I must tell you that he perspired immensely; no doubt a great deal of the heat was carried off by the sweat which came out of his skin. Young girls are accustomed in France to go into large bakers' ovens when they are at 183°, in order to attend to the loaves of bread. Though a great many animals have the same organs, and are made exactly like human beings, no other animal but man could perform this feat. Why? Simply because he has reason, and has learnt by the use of his reason that as the bottom and sides of the oven are hot, he must wear thick shoes, or his feet would be burnt by standing on the hot iron. The same reason and intelligence enable men and women to live in very hot countries, such as India. There they find they must wear much lighter clothing than they put on in England, and that they must also eat different foods. Men, you know, can live in countries where the cold is so great that for nine months there is nothing to be seen but ice and snow, and the air is much colder than frozen water. There a man has to cover himself with skins of animals, which are the warmest coverings that it is possible to get. Very little cold can pass through them into the body, or heat inside escape from them. A man finds that there, too, he must eat and drink very different food from what he would do in a hot country. In cold countries people are obliged to eat a greater quantity of fat, which contains a great deal of carbon, as you know. There is more oxygen in the same bulk of cold than of warm air. Do you not know how much more hungry you feel on a cold winter's day than you do when it is very hot on a summer's day? For instance, when you have been out skating on the ice, have you not felt after a little time so hungry that you could eat anything? In Russia it is said that a boy has been known to drink two quarts of train oil and eat several pounds of tallow candles in a day.

I will now tell you something more about the windpipe. You see that this pipe (a glass one)[1] which I hold in my hand is intended to represent the windpipe. At the entrance to it, at the back of the mouth, there is a little door. Whenever we swallow any food, the little door falls down over the windpipe and prevents any food from getting into it. Whenever we are not swallowing the door is open, so that air may pass down into it. Now, all down the inside lining of the windpipe there are rows of exceedingly small little hair-like bodies, that serve as brushes, called cilia. These cilia cannot be seen except with

[1] I showed a glass model.

a microscope. They are always waving down and up. These little cilia in the windpipe serve to send up the moist secretion of the air-passages into the mouth. When we have a cold, you know, we cough; these little brushes keep sending up the phlegm that collects in the windpipe. It is very dangerous to get anything into the windpipe, for there is no way to get it out but through the mouth. The windpipe only leads down into the lungs, and it could not pass through them. Many years ago Brunel, the celebrated civil engineer, while playing with his children, pretended to swallow half-a-sovereign. Unfortunately the half-sovereign really did drop down his windpipe, and there it remained for two or three weeks. During that time, the leading doctors in London tried to take it out in vain. As he was a very clever man, and had plenty of time for reflection, he decided that he would use the following means to extract it: A plank of wood was brought, on to which he was strapped. He and the plank were turned very quickly upside down; he kept his mouth open, and, as he expected, the quick motion made the half-sovereign fly out of his mouth. In case a child should get anything into its windpipe, one plan is to turn it with its head down, clap it on the back, and shake it.

The lungs of a large man can hold above eight pints of air. Of course the more fresh air we can get into our lungs the better our blood will be. When we walk or run we take in a much greater quantity of air than when we are still, because we breathe more frequently. We also become much warmer with exercise, because there is so much more oxygen to unite with the carbon. Girls suffer very much more than boys do from cold hands and cold feet, because they sit still a great part of the day. I am sorry to say that a great many more women and girls die of consumption than men. Dressmakers, milliners, and school-girls not only sit still for hours together, but they frequently sit in bad damp air which gets no sun. Everybody ought to know a most important fact, that when the air is damp the sweat, which is poisonous matter, cannot get freely out of the skin, as the damp air prevents evaporation and also shuts up the pores. This is why people have rheumatic fevers after sleeping in damp beds or damp sheets. The damp bedding prevents the sweat from getting out; the sweat must therefore remain in the blood, and causes the fever or cold. If the lungs are weak, the poison settles on them, and consumption is brought on. Damp shoes and stockings or damp clothes have the same effects; they prevent the sweat from coming out of the feet. We little know how much rheumatism and suffering is caused by wearing thin-soled boots and damp stockings. This is how children who sit on damp grass or earth often get hip complaints. People who live in damp situations or damp houses are constantly having colds or ailing in some way. There is very little oxygen in damp air.

Doctors now send some consumptive people to cold countries where the air is very dry and contains plenty of oxygen. In Iceland, it is said, people do not have consumption, though there they have only three months' summer and nine months' winter. Damp, impure air is equally bad for dumb animals. This is the reason why horses and cows which are kept in dirty damp stables die of consumption. The doctors say that the best way to prevent consumption is to wear warm clothing, take a great deal of exercise in good fresh air, and to eat plenty of fat food, such as butter, oil, cream, bacon, and fat. By these means the appetite will grow better, the organs be made more healthy, and the general health improve. When people understand this, they will give up buying quack medicines, send for a medical man, and carefully follow his orders. A doctor knows directly by listening to the breathing which lung is unhealthy. The great thing is to have advice before the disease has gone too far. When a person is suffering from bronchitis, some of the little pipes, properly called bronchial tubes, that carry the air into the lungs, become inflamed and partly closed, from cold or from checked perspiration. The air, therefore, cannot easily pass down through the tubes, and then the breathing becomes difficult. Directly anyone has this complaint, he ought to breath warm pure air, because warm air will make the pipes grow bigger, and then allow more air to pass down them. Cold air, you know, makes them small, and then the breathing becomes more difficult, because less air can get down. There ought to be a fire in the room night and day; the air in the room ought not to fall lower than 60° nor be higher than 70°. Deaths occur from allowing the fire to go out at night. It is possible to keep the air in a sick-room both warm and pure. It is very necessary that the air should be kept pure in bronchitis and in all cases of illness. I told you in the last lecture what pleurisy is. In consumption the lungs, which are like a honeycomb and have six millions of air-cells, become diseased and waste away. Some of the air-cells close up, so that no air can get into them; then people suffer from shortness of breath. I should like to make you in some degree understand the difference between consumption, bronchitis, and pleurisy. I have written down the names of these three different complaints, which you must copy.

I hope by means of this model,[1] which I showed you last time, to make you clearly understand that the chest, called the 'thorax,' which contains the two lungs and the heart, is entirely separated from the lower part of the body, called the 'abdomen,' by a very strong muscle. When the lungs are filling with air, the ribs rise up like the sides of a pair of bellows, and make a great deal of room, so that the lungs may swell out. The ribs cannot, like the bellows, however, press out all the air. The lungs always contain a great quantity of air. There is a skin that lines the back and front of the chest. It is this skin which is called the 'pleura,' and which becomes painful when people have 'pleurisy.' Here are the two lungs, which are each placed in bags of the same moist skin that lines the chest, and is called the 'pleura.' They are quite separated from one another, and the little heart lies snugly between them in a bag also. Here is the strong band of muscles called the diaphragm, which completely separates the lungs and heart from the abdomen, and which sinks down directly we take in a breath, so as to make more room for the lungs.

A great many children lose their lives every year from 'croup.' If taken in time, this complaint would not be so fatal. A child who is going to have the 'croup' is generally seized about ten o'clock at night (that is, when it has been in bed a few hours) with a difficulty of breathing, and the child

[1] Messrs. Stodmann's model of the chest; natural size.

soon makes an odd sound in its throat, like the crowing of a cock. A piece of membrane grows in the windpipe, and prevents the air from getting into the lungs. The only thing to be done is to send instantly for a doctor, and light a fire if it is cold weather. If a doctor is sent for in time he may be able to prevent this piece of membrane from growing in the windpipe. If you wait at all, it will be too late, for the membrane grows so very quickly.

An infant breathes very quickly, and its heart beats very rapidly, because the blood has to be pumped up very often into the lungs, to be made pure and warm by the oxygen it finds in them. There are three things that help to keep the blood warm—exercise, thought, and fat. We know that a baby has not much real fat on its bones, it cannot take any exercise, and it has not the power of thinking. When we think and study the blood goes more rapidly to our brains, as it always does to every organ of the body that is working. If a baby's head is kept hot it will dream and be feverish and restless; it is not intended that its brains should work. For that reason great care ought to be taken to keep its head cool. A baby has generally no hair on its head when it is born, and the effect of this is to keep it cool. Nurses won't believe this. They will cover the head both by day and when it is in bed, in spite of all the doctors say. Every other part of its body ought to be kept very warm, or the blood will not be able to pass through the capillaries to feed the flesh. What is the use of feeding a child with good food if the food, when it is made into blood, cannot get out of the capillaries to feed the body? Cold shuts up these wonderful little blood-vessels; therefore a child will be pined [1] unless its limbs are covered up.

It is very sad to see what ignorant ideas the richest and poorest people alike have about the way in which infants and children should be treated. I constantly meet the children of the rich and educated classes on a cold winter's day walking out very smartly dressed—hats covered with feathers and ribbons. Then I look down and see their poor little legs quite

[1] 'Pined' is a Yorkshire word for starved.

bare. These poor children are generally not allowed to run and keep themselves warm, lest they should fall and injure or dirty their fine clothes. The nurse is often cross, and the children are cross, and the little things return home very cold and very unhappy. A beggar's boy, with his bare head and his naked legs and feet, is much better off after all, because he is able to run and enjoy himself, and by that means keep warm.

More little girls die than boys every year. Mothers put their little boys into jackets and trousers at a very early age, because they like to see them look manly. The girls are left with bare arms and necks, because they are considered to look much prettier dressed in this way. The skin that is exposed to the cold air gets chilled, and then the pores become closed, and the sweat is thrown in and poisons the blood and brings on illness. Every part of the body should be covered up, except the face and the hands, with some light woollen material which will not easily take fire. Fresh air is more necessary for a baby than for a grown-up person; yet you constantly see mothers carrying their infants with a thick shawl put over their faces and mouths. If the blood becomes filled with carbonic acid gas it will not move; and directly the blood cannot get to the head all our senses fail, and we faint, or a baby will perhaps have convulsions. The only way to restore the senses is to take the persons into fresh air, and place them flat on their backs, with their head a little raised; the oxygen will then fly into the lungs and make the blood pure and alive.

A person who falls into water is suffocated, or drowned, because the water has filled his mouth and shut the little door down over the windpipe, so that no air can get into the lungs. The blood will not move from the lungs into the heart when it cannot have any oxygen; therefore the brain can get no blood and will not work; then the drowning person loses his memory and senses. The great thing is to get all the water out of his mouth. See that he has nothing tight round his neck or chest. Turn him instantly on his face, and place your hand under his forehead, and let the water run out which has gone down his throat; then turn him round; catch hold of his tongue with your fingers—do not be afraid of hurting him—and pull it out as far as ever you can. Then tie a string, if you have one—or tear off a strip of your pocket-handkerchief—across the tongue and round the lower jaw, to prevent the tongue from falling back into the throat. If it does, it will shut up the opening into the windpipe, and no air will be able to get down. Until he can breathe it is not only useless but *dangerous* to try and warm his body. Turn him again on his face, to be quite sure that all the water has come out and the air-passages are all free. Then, when he is on his back, the head slightly raised, lift his arms up and down, because when the arms are up the ribs stretch out, and the lungs can hold more air. Do this several times, till you see he tries to breathe himself. Of course do not let people crowd round; give him all the oxygen and fresh air you can. Then, if a house is near, carry him, with his head slightly raised, into it, and try to restore heat gradually by rubbing and hot blankets. Ignorant people always think the *first* thing they must do is to make the person warm. Now this is a very dangerous thing to do, because the blood cannot circulate until fresh air can get into the lungs. People have been known to come to life when they have been in the water for some time, because the heart may continue to beat very softly long after the senses and memory have failed.

Directions about bathing will be found in Appendix I.

### *Things provided for the Lecture.*

Stodmann's model of the chest containing the lungs and heart.
A thermometer.
Glass windpipe with epiglottis and bronchial tubes.

### *Questions for the Eighth Lecture.*

1. Is the heat of our blood always the same in summer and winter?
2. Why do damp beds, damp clothes, wet feet, and damp, impure air give people rheumatism, fevers, colds, consumption, and other complaints?
3. Why do more little girls than boys die every year from chest complaint?
4. What would you do it a person fainted?
5. How would you try and bring back life to a drowning person?

## LECTURE IX.

### *THE BRAIN AND NERVOUS SYSTEM.*

The first part of my lecture to-day will be upon the brain, which lies in the skull, and also about the nerves, which come from the brain. I shall tell you more about the nerves when I tell you about the senses.

The skull, you know, is a very strong box made of twenty-two bones, which are fixed together in the form of an arch above, as you see in this picture of a human skull. It rests on the top of the spine, or backbone. Here is a picture of the top part of the brain; you see it is divided into two equal parts. These two divisions are called the big brain. They may well be called the big brain, because they fill up the forehead, and the top of the head, and extend to the back of the skull. The proper name for this part is the cerebrum. You would not think, by looking at the picture of the big brain, that it is only one mass of brain, but it is possible to take the big brain and make it lie flat in one whole piece.

I will just try and crumple up my pocket-handkerchief into folds, to try and make you understand why the brain appears as it does. These folds are called convolutions. A doctor could tell you a great deal about them. It is said that clever people have a great many more convolutions than stupid people. If you were to pinch or press the big brain you would cause no pain, as it contains no nerves of feeling; but a *blow* would do it great injury, because it would take away all power of memory and thought. You know how a blow or a fall on the head will stun either a human being or a dumb animal, so that it forgets for a time all that has happened. A sailor once fell from the rigging of a ship on to the deck, and was taken up insensible. He remained insensible for several months at a hospital in Gibraltar. Apparently his body was healthy all the time, for he ate and drank and slept well; the only motion observed was the constant moving of his fingers, and of his tongue and lips when he required food. At last he was brought over to England. Mr. Cline, a celebrated London surgeon, examined his skull, and found that a piece of the bone had been pushed in, and was pressing upon the big brain. The sailor had now been unconscious for thirteen months. Directly Mr. Cline lifted up the piece of bone, and all pressure was quite taken away, the man ceased to move his fingers. A few hours after the operation he was able to sit up in bed. At the end of seven or eight days he walked

Fig. 20.

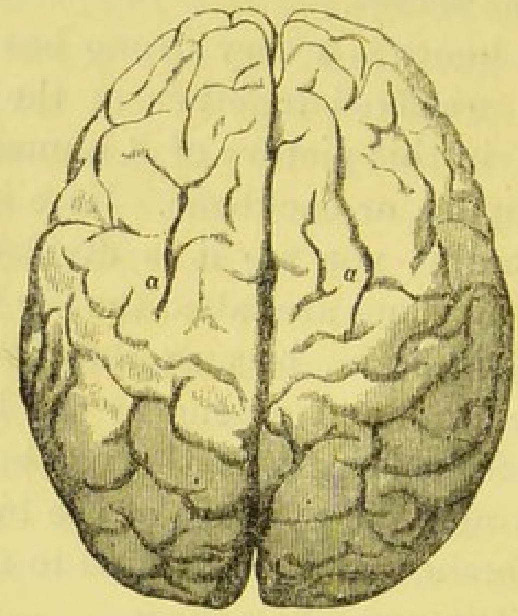



Diagram of the top part of the big brain, or cerebrum, showing how it is divided into two parts, also that the brain does not lie flat, but is crumpled up into what are called convolutions.

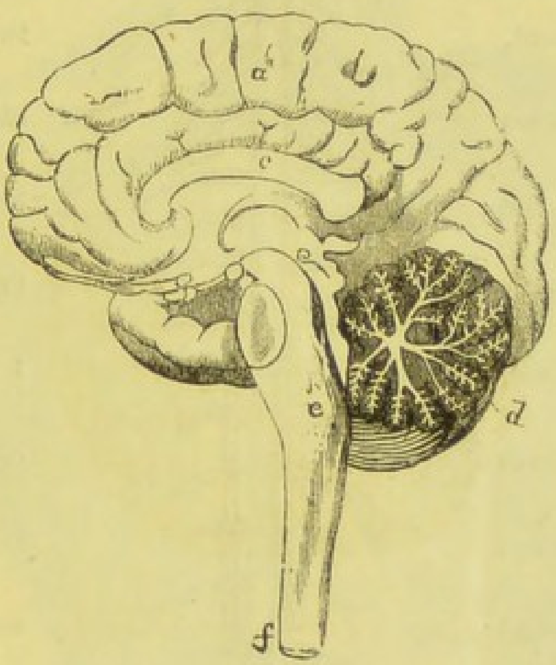
about and could remember and tell of all that happened *before* the accident, but he could not recall a single thing that had happened during his illness.

I think if nurses could hear what I have just told you about the brain, they would never again venture to press the bones of a baby's head together. The part of the brain which looks in this picture like the branches of a tree, and is placed under the great brain, is called the little brain, or cerebellum, *d*. It also is incapable of feeling pain, but may be injured in the same way as the big brain by pressure. The nerves of feeling come from this strange-looking part, *e*, which is placed under the little brain.[1] A part of this nerve-substance passes down

[1] Marshall's diagram, No. 7.

from the head through the middle of the backbone like a white cord. It is called the spinal cord, *f*. You can see two small nerves that look like threads come out between the bones on both sides of the spine, in the neck, back, and loins. There are thirty-one pairs of nerves; they spread out like a fine network and reach every spot in the body.[1] When you prick yourself with a pin it causes you pain, because the needle has touched a nerve. We have two skins. This outer one has no nerves in it, as you will find by rubbing it, or by

FIG. 21.




Half the brain. *a*, inside view of the big brain, showing the convolutions, or how the brain is crumpled up; *c* is the part where the two halves of the brain are joined together; *d*, half the little brain, showing the curious white threads, like a tree (*arbor-vitæ*), that run through the grey matter of which the little brain is made; *e*, medulla oblongata; *f*, part of the spinal cord.

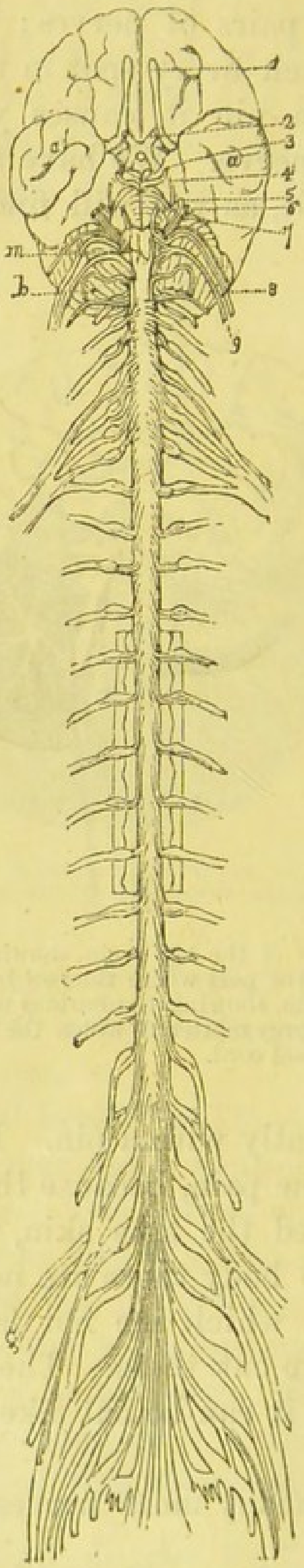
scratching it very gently with a pin. Directly the pin passes through it you feel the pain, because the nerves are placed in the second skin, called the true skin, under the first. Then in some parts of the body there are no nerves; for instance, the tips of our nails, which are not fastened to the flesh, do not feel pain when we cut them. The hair on our head has not any; that is why it can be cut like the nails and feel no pain.

We have a great many more nerves in some parts of our

[1] Marshall's diagram, No. 7, fig. 22, page 66.

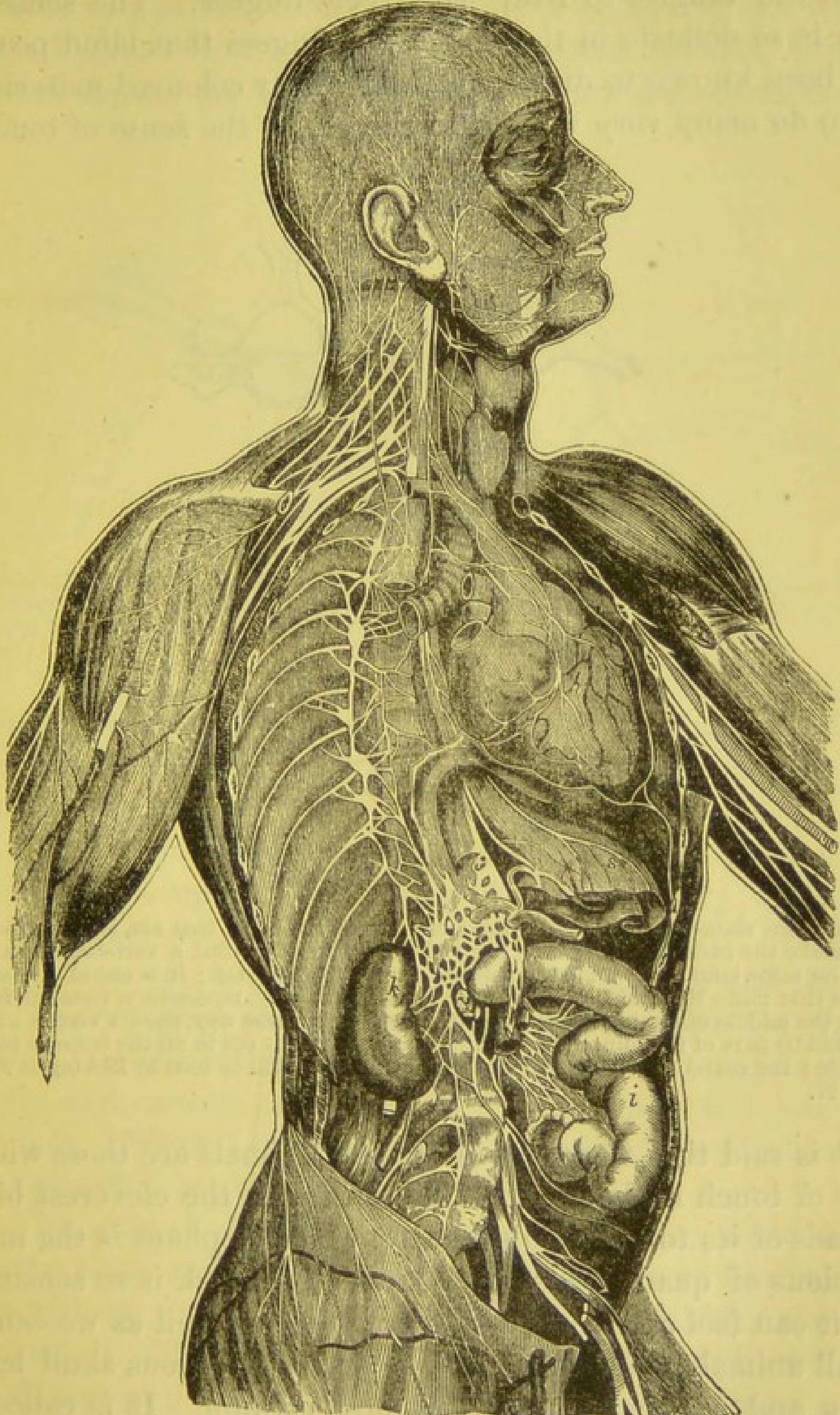
bodies than in others, as the lips, tongue, feet and hands; the tips of our fingers are very sensitive; they are provided with

Fig. 22.




Front view of the contents of the skull and the spinal cord, with all the nerves that go from the bottom of the brain up into the head, such as the nerves of sight, hearing, taste, smell, and the nerves that come out of the spinal cord as it passes down through the backbone, called also the vertebral column. *a a*, the two halves of the big brain (cerebrum); *b*, little brain (cerebellum); 1 to 9, the nerves of smell, sight, hearing, taste, &c.; *m*, medulla oblongata. All the other nerves pass out to different parts of the body between the bones, or vertebræ, of the spine.

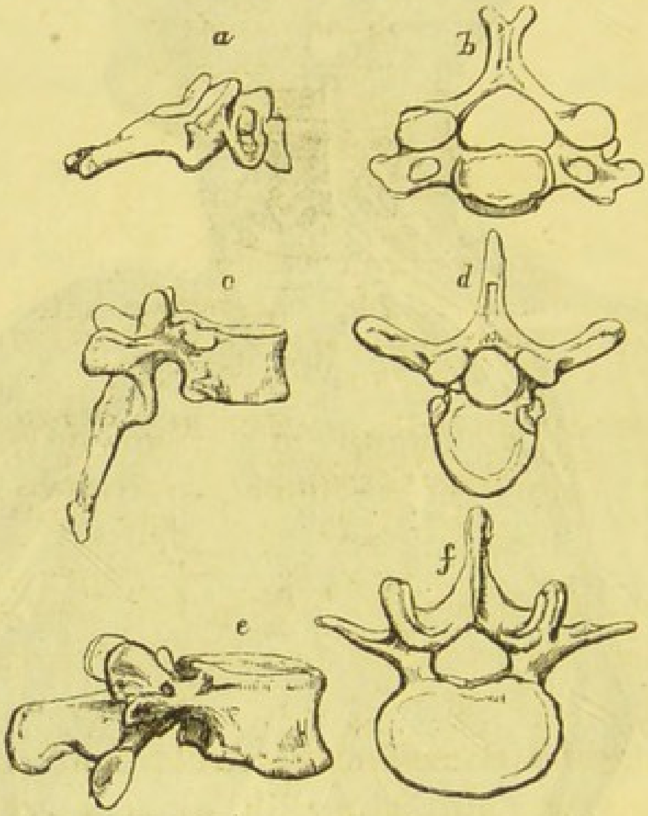
Fig. 23.



View of the nerves. They look like fine white threads, and spread like network over every part of the body. They can be seen going to every organ and muscle to make them move and do their work. *h*, the heart; *s*, part of the stomach; *i*, piece of the bowels; *k*, kidney. This kidney is the right kidney, though in the picture it appears to the left.

a great many little nerves. It is by this means that blind people are taught to read with their fingers. The sense of touch is so delicate in the tips of the fingers that blind people have been known to distinguish differently coloured materials, and to do many very wonderful things, by the sense of touch.

Fig. 24.




This diagram shows the different shapes of some of the bones that are joined together and make the backbone or spine. Each of these bones is called a vertebra. *a* and *b* are the same bone, only *a* is seen sideways and *b* from the top; it is one of the seven bones that make the neck. *c* and *d*, seen in the same way, represent a vertebra taken from the middle of the backbone. *e* and *f*, seen in the same way, show a verteb a from the middle part of the loin. The pointed part that stands out in all the bones is placed outside; the round smooth part lies inside the body, as will be seen by looking at fig. 9, page 27.

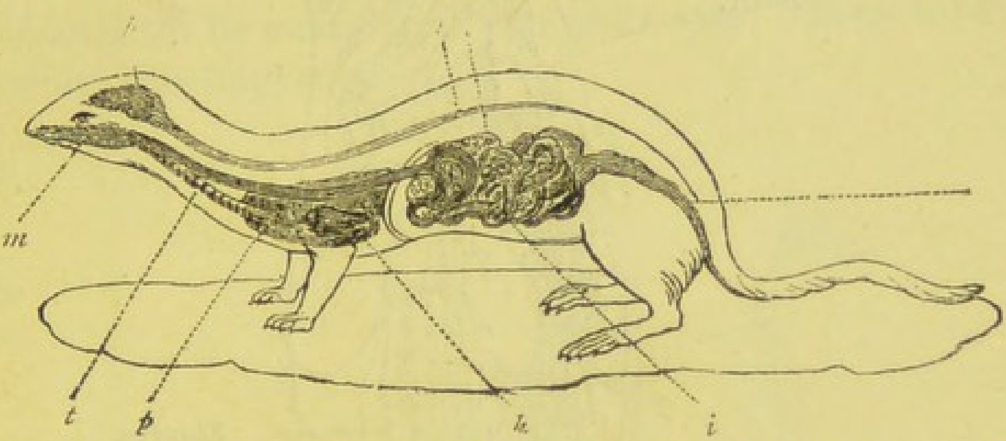
It is said that the most intelligent animals are those whose sense of touch is the finest. The parrot is the cleverest bird, the pads of its toes are so sensitive. The elephant is the most sagacious of quadrupeds; the end of its trunk is so sensitive that it can feel and handle objects almost as well as we can.

All animals which have a bony or cartilaginous skull have brains and a backbone, or vertebral column. It is called a vertebral column because each of these little bones by which it is made is called a vertebra.[1] All animals which have a

[1] I showed two or three of these bones.

vertebral column are called vertebrate animals, and many of them have organs like those of a human being, though they are not all placed in the same way. In some animals, however, certain organs are absent; in others they are represented by

FIG. 25.




Vertebrate animals have the same organs as human beings. This picture shows how the different organs are placed in a weasel. *m*, mouth; *b*, brain; *t*, windpipe; *p*, lungs; *h*, the heart; *l*, liver; *i*, intestines and stomach; *s*, spinal cord.

organs performing a similar office, but having a different structure. Fish, for example, breathe by means of gills; they have no lungs.

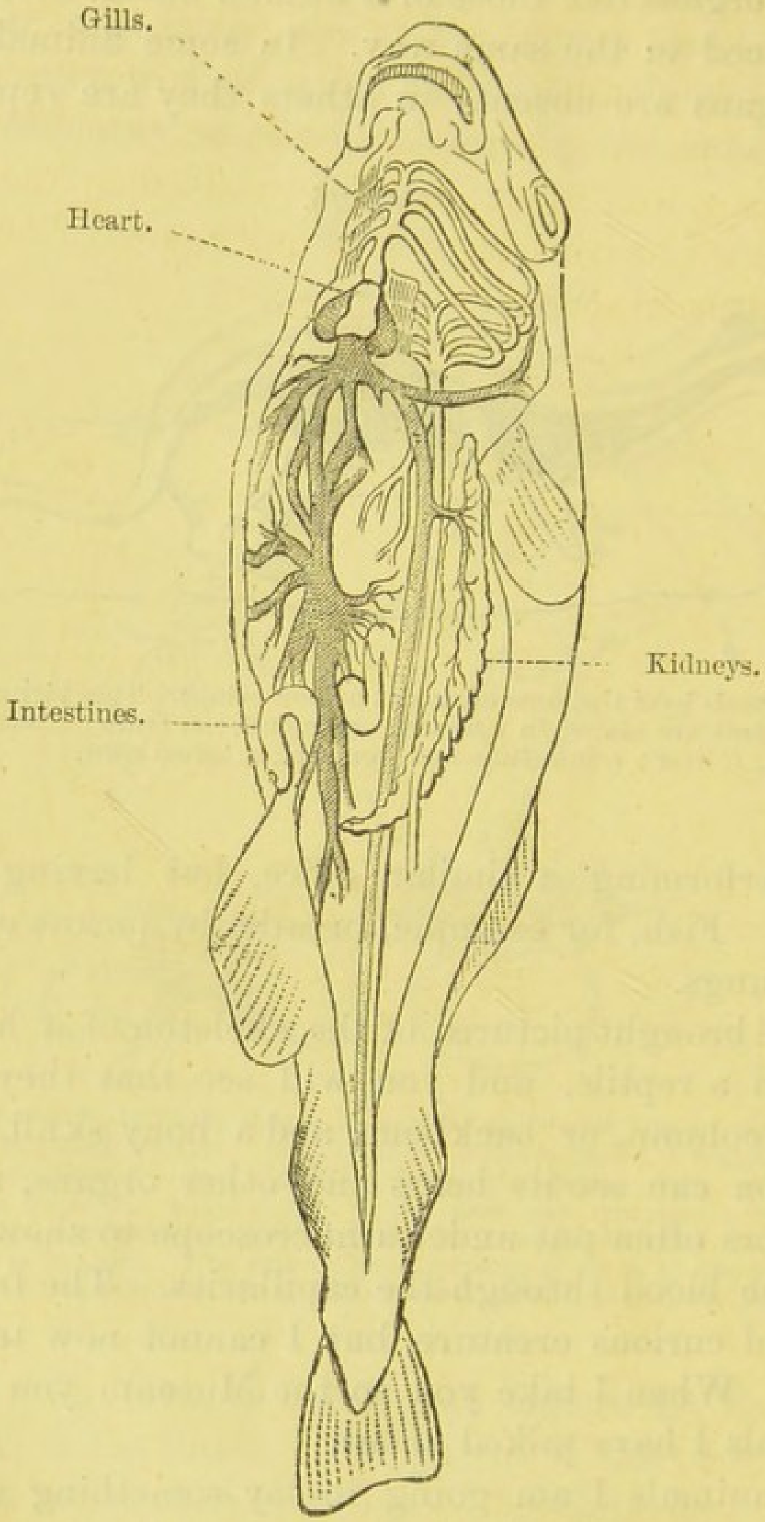
I have brought pictures of the skeleton of a horse, a bird, a fish, and a reptile, and you will see that they all have a vertebral column, or backbone, and a bony skull.[1] Here is a frog. You can see its heart and other organs, and its foot, that doctors often put under a microscope to show the circulation of the blood through the capillaries. The frog is a most useful and curious creature, but I cannot now tell you more about it. When I take you to the Museum you shall see all the animals I have talked about.

The animals I am going to say something about to-day are the horse and the donkey. Look at the horse's skull, and you will see that it has a very different shape from the skull of a man.[2] The horse's skull is flat at the top, and has a very small 'great brain.' All animals except man have a very small quantity of brain at the top of the head. You know it

[1] Skeleton of a horse, page 72.

[2] Show a human skull, or picture of one, page 21.

Fig. 26.

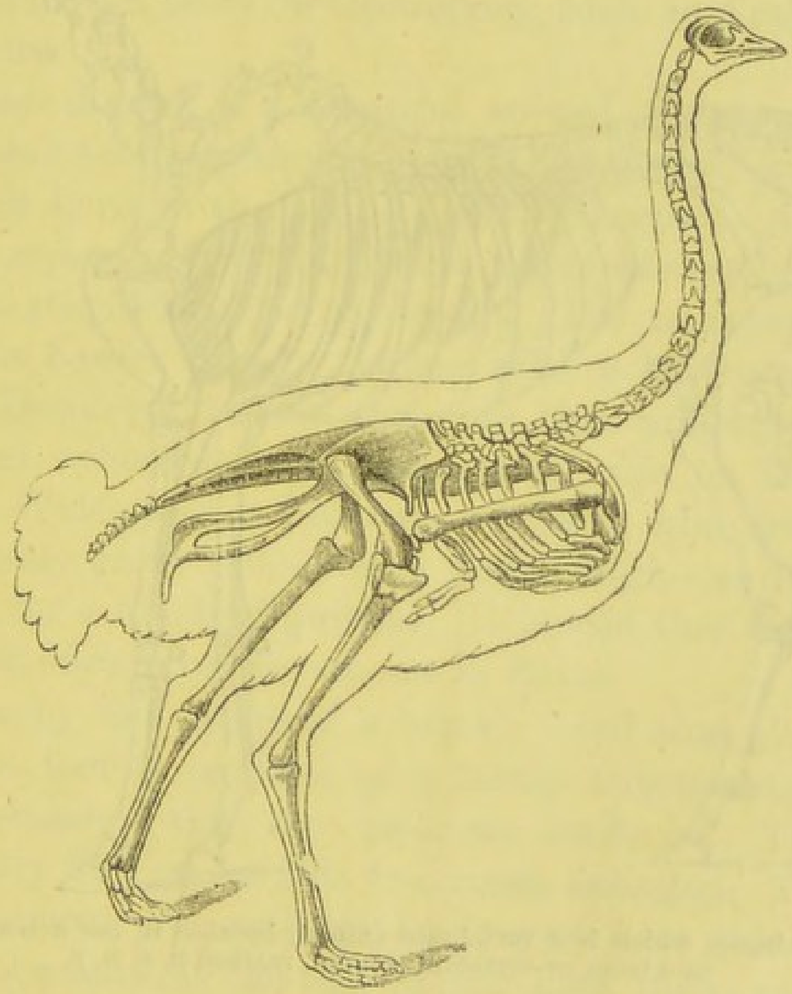



Vertebrate animal, because it has a bony skull and backbone.

is that part of the brain which gives us the power of reasoning, and ought to make us superior to all other animals

Horses are very intelligent and have excellent memories. They never forget those who are kind to them, and can be made to do anything by a master they love. On the other hand, a horse does not forget those who have treated him cruelly, and will refuse as long as he can to obey them. He is courageous, and will do his best to defend a friend who is weaker than himself. There was once a small dog that had lived a great deal in a stable. One day a big mastiff attacked him. Directly the horse saw this he went up, kicked the mastiff away, and sent him flying, and then walked by the side of his little friend till he considered him quite safe. They were in a field when this happened.

Fig. 27.

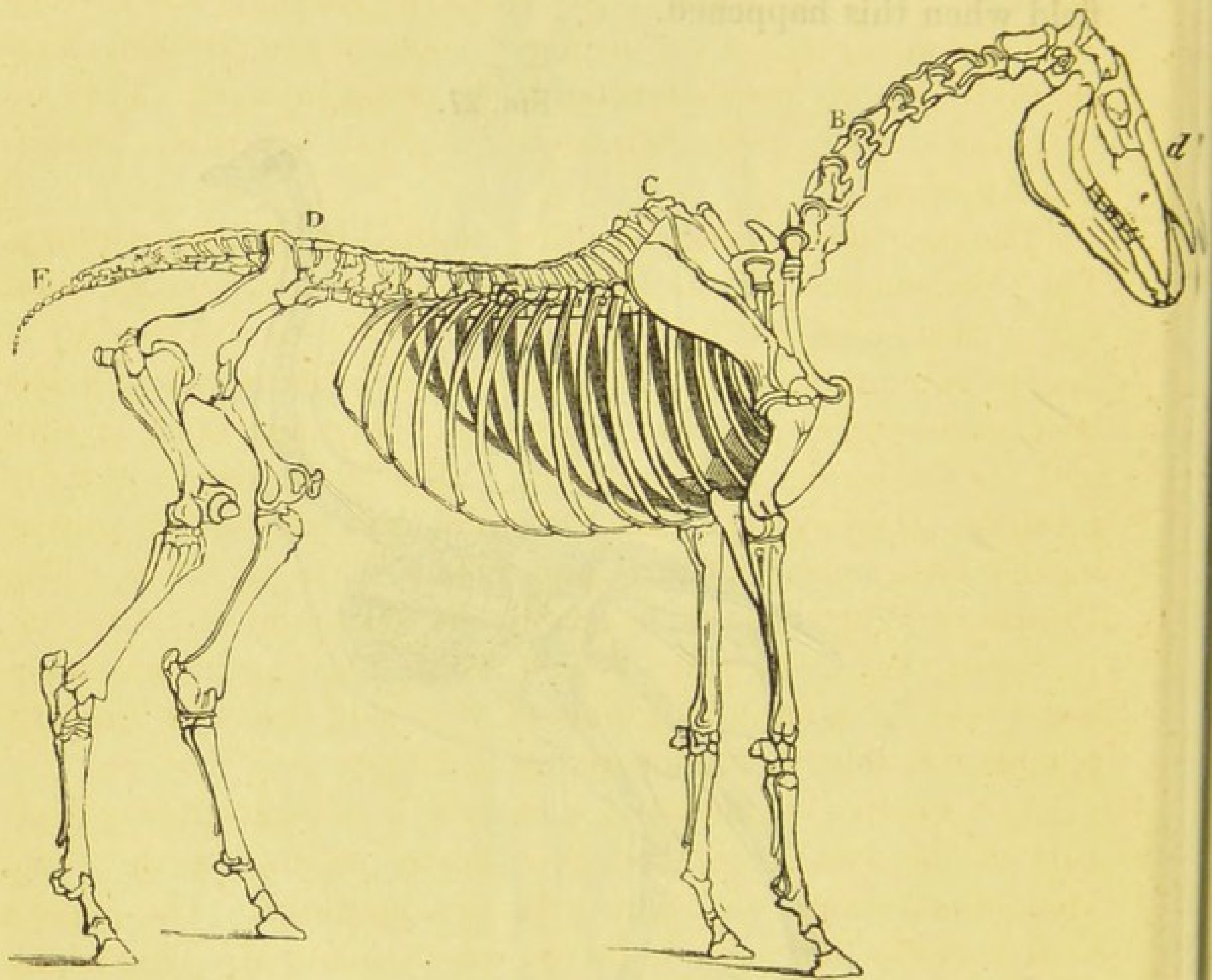


Birds are vertebrate animals.
This is a picture of an ostrich; it has a bony skull and a backbone.

Horses have so much affection that they have been known, it is said, to die of grief on losing a kind master or an old companion. They are very timid and nervous animals; therefore we know their bodies are well provided with nerves. A thunderstorm has made them tremble all over like a leaf. The reason why horses shy at objects on the road is because they are afraid of them. Directly they understand what the object is their fear passes away.

The nerves of the horse, like the nerves of a human being, come out from between the bones of the spine, and spread into every part of the body.

FIG. 28.




Skeleton of a horse, which is a vertebrate animal, because it has a bony skull *d*, and backbone, or vertebral column, marked B, C, D, E.

I told you that we had a great many more nerves in some parts of the body than in others. The soles of our feet have so many that we can scarcely bear to have them touched. People have been tickled to death; in some countries this has been one way criminals were put to death. I am now going to tell you how wonderfully a horse's foot, called a hoof, is made. If you look at the feet of a horse you will see they are no bigger than our feet, though they have to bear so great a weight. I will now show you the model of one which I have in this box.[1] You see it has not five toes as we have; it has only one toe, ending in a solid piece, which supports the hoof. There are only three other animals that have a foot in one piece. They are the donkey, the zebra, and the quagga.

Horses and donkeys live wild in hot countries where there are great plains of sand, as well as in countries where there are wide tracts of grass. Our roads in England are so very hard and stony that it is considered necessary to put iron shoes on their feet to prevent them from being injured. They do not wear shoes in their own countries, such as Arabia, Persia, and America.

The poor donkey is a beautiful animal in its own country. The Persians bring up the little foals upon milk, and let them live in their tents as the Arabs do their horses. A donkey is said to be more sensible and gentle than a horse before it has been made stupid by cruel treatment. The more sense an animal has the harder it is to manage after it has been unkindly treated. Donkeys are sold for more than a hundred crowns in the East, where princes and nobles ride on them. The Prince of Wales had a beautiful one sent him from Egypt. In Spain they grow tall—fifteen hands high—and are sometimes sold for a hundred guineas. It is said that five hundred pounds was once given for an ass in Rome.

You see by this model of a horse's hoof that all the front part of the foot is covered by a horny substance, the same kind of substance that our nails are made of. The horse's hoof is really like our middle toe, much enlarged. This horny substance is nearly an inch thick; it grows as quickly as our nail does, because at the top of the hoof there are a great many arteries and capillaries that feed this horn with blood and make it grow quickly. It grows downwards. It is smooth and bright, and looks as if it had been polished; this polish prevents any water from getting through. The under part of the foot is called the sole, as we call the under part of our foot a sole, only a horse has two soles instead of one. This that you first see is the horny sole; it sinks in a little, so that

[1] I showed Auzoux's model of a horse's foot.

the nail that projects round the edge of it can protect it. Towards the back part there is this raised part like a cushion; it is called the 'frog.' The frog is a most wonderful and useful part, for when it rests constantly on anything hard it becomes so tough and hard that even a piece of glass will not hurt it. By this means the horse is able to pass over the most stony roads in its own country, where it is not shod. Some people think it would be better not to shoe them at all in England.

I will now take off the hard polished hoof, or nail, and the horny sole and frog, in which there are no nerves, and show you how delicately the under sole is made. You see it is covered with nerves, arteries, and veins. The whole of the front of the hoof has these little white lines, like the leaves of a book, which run from the top of the hoof to the bottom, called laminæ. There are no less than three hundred of them; they are all made of a soft substance, containing many nerves. This is that part in our toes and fingers which we call the quick, which lies under the nail, and hurts so dreadfully if anything sharp runs down the nail.

Now you must look and see how beautifully these three hundred laminæ are guarded by the horny covering, or shoe. Each of the laminæ is placed in a little horny groove to protect it. Under them you can see the bone of the foot, which is called the coffin bone. There are a great many little holes in the coffin bone for the arteries and veins to pass through, so that they may not be hurt by any pressure. Here is the tender sole, where there are so many nerves.

Everything is done by nature to guard the foot. I am sorry to say there are ignorant blacksmiths and grooms who do their best to spoil all that God has done. First they put on iron shoes of an immense weight, and then they fasten them on by too many nails, which are sent in too far, till they touch some of the tender parts. Sometimes they make the foot fit the shoe by cutting away the horny part till it has the same shape as the iron shoe. Some people consider it an improvement to scrape the polished hoof with a knife; then the wet gets in, and the nail becomes rotten and breaks away, so that there is very little horny substance to fasten the nails to.

There are knives made on purpose to shave off some of the frog, or soft cushion; then the horse, having nothing to protect the tender sole, becomes lame. Cracked heels are often caused by cutting away the little tuft of hair that is placed at the back of the foot to guard that part.

Exercise is necessary for horses; the feet are very much injured by standing still in a hot, damp stable. The feet then grow tender, and the frog and horny sole grow smaller, so that the nerves and blood-vessels get squeezed together, and grow small and weak.

The donkey's foot is very like the horse's; the only difference is, that the donkey's hoof is longer and the sole more hollow. It is by this means that it can walk in rough and steep places better than the horse, because its hoof digs into the earth, and gets a better hold of it.

### *Things provided for the Lecture.*

Marshall's diagram of the nerves, No. 7.
Drawings of the skeleton of a horse, dog, bird, fish.
Drawings of the organs of a frog.
Auzoux's model of the horse's hoof.
The words *Vertebral Column* and *Vertebræ* were written up in large letters on the blackboard.

### *Questions for the Ninth Lecture.*

1. Describe all you can remember about the brain.
2. Should we suffer pain if we had no nerves?
3. Name some of the parts of the body that have no nerves and those parts that have the most nerves.
4. Do you remember why all animals who have a bony skull are called vertebrate animals?
5. Tell me all you can remember about the horse's hoof, and how it is injured by ignorant blacksmiths and grooms.

## LECTURE X.

### *DIGESTION.*

TO-DAY we are going to hear about the way in which the food we eat is digested—that means, how it is changed by the different organs of digestion, and made into blood.

I will first point out where some of the largest organs of digestion are placed in this part of the body called the abdomen. The abdomen is separated from the chest by a large muscle called the diaphragm.[1] Here is the stomach, lying nearly in the middle, close under the 'diaphragm.' The liver is above and to the right of the stomach, and the intestines, or bowels, are beneath the stomach. This muscle called the diaphragm is a very important part, and I will try and explain how curiously it moves.

When you take in a deep breath of air, your ribs swell out, and so do the lungs. The diaphragm, instead of rising up at the same time that the ribs do, sinks down, and so makes room for the lungs to grow as big as they can. Draw in a good breath, and you will see that this is the case.

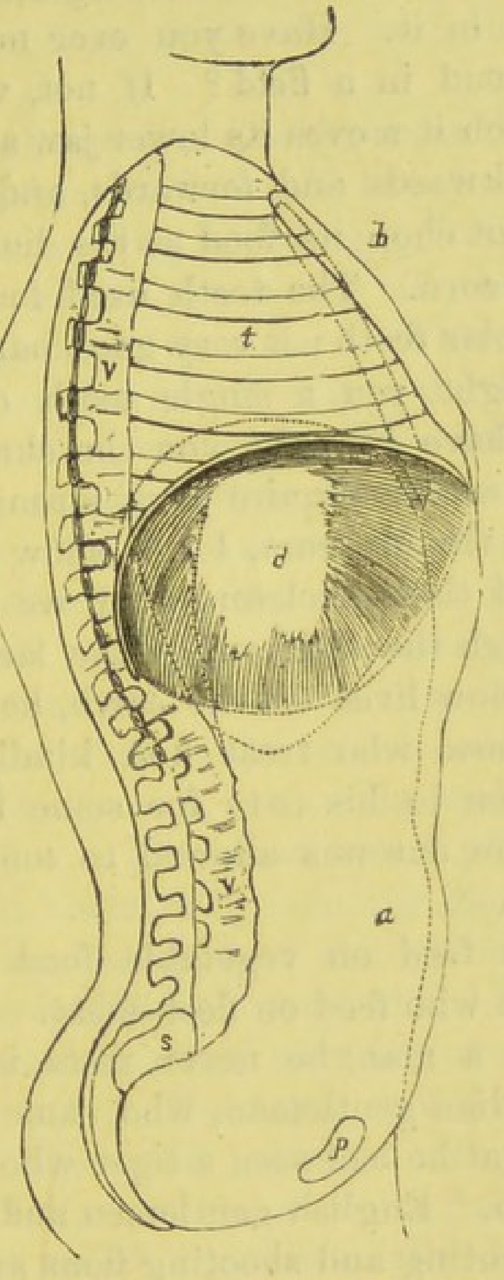
Our blood, as I have before said, contains at least forty different substances. The food is first changed in the mouth. The mouth is a strong box of bone which contains the tongue and thirty-two teeth, sixteen at the top and sixteen at the bottom. A learned man would at least give you one lesson entirely about teeth. I can only tell you enough about them to make you understand that God has given us different kinds of teeth, so that we may be able to eat both animal and vegetable food.

Animals which live on nothing but flesh—that is, by eating other animals—have very different teeth from those who eat nothing but grass. I have brought the skull of a lion. A lion, you know, eats nothing but animal food. You see he has four enormous teeth, two on each jaw, called canine teeth, for holding the prey, besides numerous molar teeth. Between these canine teeth the flesh is caught and pierced and torn,

[1] Marshall's diagram, No. 3, page 4.

whilst the molar teeth cut it to pieces as knives would, because their edges are very sharp like knives. The lion can only

FIG. 29.




Side view of the trunk of the body, showing how the diaphragm *d* divides the chest or thorax *t*, from the abdomen *a*, where the stomach, liver, bowels, and the other organs of digestion are placed. The ribs in the picture are spread out as far as they will go, because the lungs are full of air ; *b* is the breast-bone, or sternum.

move his lower jaw up and down, like a chopping-machine, not from side to side.

It is impossible for man or any quadruped to move the upper jaw, as the upper teeth are placed in those bones of the face which cannot move. I have brought the same human skull you saw at another lecture,[1] as it has a very perfect set

[1] I showed a human skull, and how the lower jaw moves.

of teeth. A human being can, you see, move his lower jaw not only upwards and downwards, but backwards and forwards and from side to side.

A cow is an animal that eats nothing but grass, with certain plants growing in it. Have you ever noticed a cow eating or chewing its cud in a field? If not, watch one, and you will see how much it moves its lower jaw about—upwards and downwards, backwards and forwards, and from side to side. The cow does not chop its food as the lion does; it grinds it as the mill does corn. The teeth used for grinding food are called mill or molar teeth; a very good name for them.

I have brought you a single tooth of an elephant. I should like to have brought you the skull of an elephant, but I found it would require four strong men to carry it. When we go to the Museum, I will show you all the different animals and their skeletons that we have talked about together. Though the elephant is the largest and strongest quadruped that now lives on the earth, he is also one of the gentlest with those who treat him kindly. Mothers have left their children to his care for some hours. They were perfectly safe; no one was allowed to touch them until the mothers' return.

Animals who feed on vegetable food are always more gentle than those who feed on flesh-meat. If a lion has once killed and eaten a man, he never rests until he has found another. An Indian gentleman, who came from Bengal, told me last winter that he had seen a tiger who had eaten at least two hundred men. English gentlemen and native gentlemen in India enjoy hunting and shooting lions and tigers. Working-men who are natives are not allowed to kill them. The consequence is that there are so many tigers that they roam about and kill and eat up great numbers of people. Travellers frequently find villages quite deserted. Directly the people hear that these animals are approaching they fly to other places for safety.

Now we must examine the teeth in the human skull, to see what teeth we have. There are eight small cutting teeth, four in the upper jaw and four in the bottom jaw; they come in the front. Between them and the three double teeth there are three other teeth on each side in both the upper and the lower jaw-bone; they cut up the butcher's meat we eat. The double teeth are molar teeth; they grind the vegetable food. It is therefore intended we should eat both animal and vegetable food, as we have teeth that will chop up foods of every kind.

Our food is first changed, as I told you, in the mouth. But before we put any food into it I should like you to fancy yourselves standing before a pastry-cook's shop, feeling very hungry. What would happen directly you saw all the good things? Your mouths would begin to water. Where did that water come from? You have taken nothing to drink for some time. This water came from some wonderful little organs called salivary glands. You see this little glass; it is of the shape of an almond.[1] It has a little pipe at the end of it. This almond-shaped bulb is something like the simplest form of a gland; but the glands which make the saliva consist of numbers of little sacs opening into the ends of a branched tube called a duct. We have six of these in the mouth—one in each cheek, and one under the tongue on each side, and one below each side of the lower jaw. Three and a half pints of saliva are said to pour out of them daily into the mouth. No organs seem to me more wonderful than the glands. There are a great many of them in different parts of the body.

We will now take a mouthful of meat into our mouths, and see what happens to it. The teeth will first cut it up into small pieces; the saliva will make it soft, and the tongue will roll it into a ball, and send it to the back of the mouth. At the back of the mouth there is a little door of flesh that hangs from the upper jaw. Directly the ball of food touches this little door it will be lifted up and cover an opening there is into the nose, to prevent any food from getting into this opening. The little door that covers the windpipe will close at the same time, and the ball will roll over the door into the gullet. Here are two glass tubes placed together as the windpipe and gullet are placed; the red pipe is intended to represent the windpipe, and the yellow pipe is the

[1] I showed a glass bulb in the shape of an almond.

gullet.[1] The gullet is the tube that carries the food into the stomach. Remember it lies behind the windpipe, nearest to the backbone.

The ball of food that has just been made in the mouth will not run or fly down the gullet as we think it does. The food will pass gradually downwards. It is first held by the muscular fibres at the upper part; then these muscular fibres press it on until, step by step, it reaches the door that opens into the stomach. It is not, then, because you are standing up that your food goes down into your stomach; it would go down just as well if you stood on your head. I dare say you have seen a juggler perform the wonderful feat of drinking a glass of water when he was standing on his head. The water goes down step by step, just as the solid food does. Cows and horses and all four-footed animals eat and drink with their heads down. They have no difficulty, because their food passes along a gullet made like ours.

Now I must tell you something about the stomach. No doubt you have all seen and heard a bagpipe that men play in the streets. It is an instrument which Scotchmen make with the stomach of a pig. The stomach of a man is of exactly the same shape.[2] It has three layers of muscular fibres. In the outside one there are fibres which pass downwards over the stomach; in the middle one they go round it; in the inner one they pass down obliquely. The fibres which pass downwards shorten the bag; those which go round it make it narrower, and the inner fibres draw the sides of the bag over the food. By this means the stomach keeps moving the food that is in it up and down, just as a churn moves the milk about to make it into butter. Inside this is another thin skin, which is very smooth and has a beautiful pink colour. This is all I shall tell you about the organs of digestion to-day.

Before I finish my lecture I should like to tell you something which I dare say a great many of you already know about water. Water is made of two gases, oxygen and

[1] I showed two glass pipes (the windpipe was red, the gullet yellow); they were fastened together to show the position of the two pipes.

[2] I showed Ramm and Stodmann's model of a human stomach.

hydrogen. You have already heard from me a great deal about oxygen gas. Hydrogen is the lightest of all gases, and for that reason balloons have been filled with it. A balloon, though it looks so large when it is filled with this gas, is lighter than the air about it, and therefore rises up. This balloon is full of hydrogen; it will therefore float up to the top of the room.

You must copy down what is written about water on the blackboard:—In nine pounds of water, eight pounds of the whole weight would consist of oxygen; only one pound of that quantity would be hydrogen. Oxygen is sixteen times heavier than hydrogen.

### *Things provided for the Lecture.*

Marshall's diagram of the viscera, No. 3.
A picture of the gullet and intestines.
Two pipes to represent the gullet and windpipe in glass.
A little glass bladder and pipe to represent a simple gland.
A balloon filled with hydrogen gas.
A bottle of oxygen gas.

### *Questions for the Tenth Lecture.*

1. How are the lungs and heart kept quite separate from the stomach, bowels, and other organs which lie in the abdomen?
2. Tell me something about our teeth, and why we can eat all kinds of food.
3. What happens to our food when we put it in our mouths, and how does it get down into the stomach?
4. What is the name of the pipe that carries our food to our stomach?
5. What are the names of the two gases that form water?

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## LECTURE XI.

### *DIGESTION* (*continued*).

You must all listen very attentively to what I am going to tell you. It is this, that unless the food we eat will mix with water, it cannot be turned into blood. We have a great deal of water in our bodies. If a person weighs 154 pounds, 111 pounds of that weight will be water, and that only leaves 49 pounds of solid matter.

In some countries it is the custom to burn dead bodies instead of burying them. This custom is called cremation. There are now a great many doctors and clever good people in England who much approve of this plan, as they consider the air that comes from a cemetery very unhealthy. It may cause fever, diarrhœa, or common cholera; therefore dead bodies ought to be burned, and not put into the earth. A great part of our bodies turns into different gases, when we are burnt; the part left, that would not burn, is called ashes. The ashes are made of mineral substances, such as phosphorus, lime, and iron. A French gentleman was once burnt. Enough iron was found amongst his ashes to make into a ring, which a friend wore.

At my last lecture I described how the food, when it is put into the mouth, is chopped up by the teeth and made soft by the saliva. The tongue then rolls it into a ball and sends it to the back of the throat. The ball passes over the windpipe into the gullet, down which pipe it gradually descends until it gets to the opening through which it passes into the stomach. I described the shape of the stomach, and the coats it has, but I did not tell you what happened to the food when it got into the stomach. To-day I intend to tell you how a wholesome dinner of potatoes and roast beef is turned into good blood. The beef must consist of fat as well as lean meat. I shall take no liquid; that means, neither water nor beer.

The beautiful smooth pink skin that lines the stomach is all covered with small spots, the openings of the gastric glands. Directly the food has passed down the gullet, and entered the little opening on the left side of the stomach, these glands pour out a fluid called 'gastric juice.' This juice will change the food into a thick fluid called chyme, about the thickness of pea-soup. As the stomach is constantly contracting and moving about, the food is rolled about, as I before said, as if it were being churned. The gastric juice helps to dissolve it and changes it into this thick fluid, chyme. This chyme then passes down to the door at the other end on the right side, to try to get out. If the fluid is thin enough, and the food has been sufficiently churned or reduced into small pieces by the constant movement of the stomach, this door will open and let it pass through, but if it is not properly digested the door will not open. It is sent back to be moved about until it is made into a proper state.

It is said that fourteen pints of gastric juice are poured

FIG. 30.

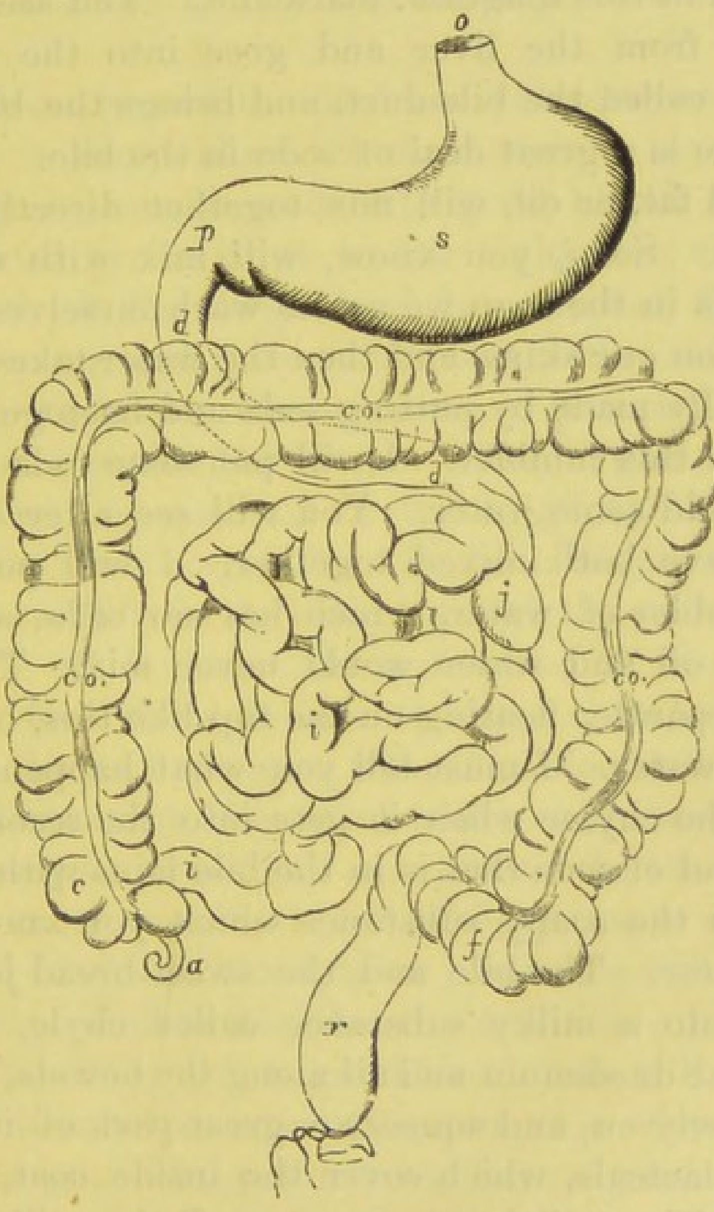



Diagram showing the stomach *s* and the bowels, or intestines; *o*, the door into the stomach from the gullet; *p*, pylorus, or door through which the food goes into the second stomach, called the duodenum, which is joined to the small intestines, that are twisted about and marked *j*; *i* is where the small intestine is fastened to the large intestine, marked *c o*, *c o*, *c o*. This large intestine, or bowel, goes up then across, *over* the second stomach, and then it comes down and ends in the part called the rectum, marked *r*.

daily into the stomach. This juice contains a very powerful acid; it can dissolve metals, such as iron and silver, but it cannot change fat. Fat is only melted in the stomach; but you know it must be changed by *some* organ, so that it will mix with water, or it cannot be made into blood. Fat and water won't mix together.

Directly the food passes this little door on the right side of the stomach it enters the first part of the small intestines, named the duodenum, which has been sometimes called the second stomach. There is, you see, a picture of this part of the intestine in this diagram, marked *d.* You see that a small tube comes from the liver and goes into the duodenum.[1] This tube is called the bile-duct, and brings the bile from the liver. There is a great deal of soda in the bile.

Soda and fat, or oil, will mix together directly, and they make a soap. Soap, you know, will mix with water. The soda which is in the soap we use to wash ourselves with mixes with the oil on our skins, and then the water takes the dirt off. Soap is usually made by putting soda and fat together. Here is some oil in this tumbler. I will put some soda into it, and then I will add some water. You will see after a little time that they have both mixed together. I will pour some oil into this tumbler of water, which has no soda, and you will find that the oil and water would never mix. The oil[2] will keep quite separate, floating on the top like this, because it is lighter than water. I must tell you what happens to the fat which is in the chyme when it gets into the second stomach. The compound of soda that is in the bile joins with the fat and turns it into the soapy substance which you know mixes so well with water. The bile and the sweet-bread juice change the chyme into a milky substance called chyle. There are muscles in the duodenum and all along the bowels, which push the chyle slowly on, and squeeze a great part of it into little pipes, called lacteals, which cover the inside coat, or skin, of the bowels. These little pipes carry off the milky fluid to a great many little glands that are placed at the back of the bowels. These glands are called the 'mesenteric glands.'

Now I must tell you what a curious thing happens to the chyle when it enters these wonderful little organs called the

[1] Marshall's diagram, page 83.

[2] I showed a tumbler of water with the oil on the top.

mesenteric glands. About half of the chyle is gradually changed into little round bodies, called corpuscles, and they float along in the rest of the white milky fluid through pipes which take it to a kind of bag that is placed in front of the spine, or backbone. To this bag a pipe is fastened which goes up by the backbone. The little white bodies go along swimming up this pipe in the white milky fluid until they come to the neck, where two veins meet.[1] In one of the veins there is a little door, and the fluid passes through this door into the vein.

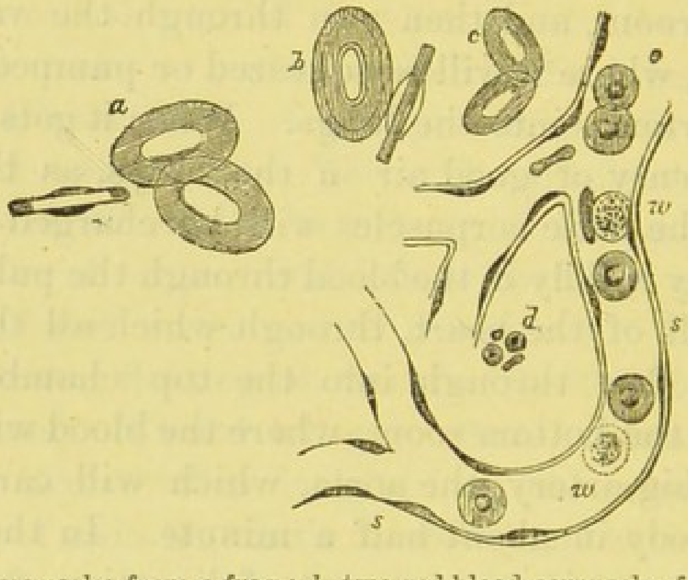
Now we have turned the beef and potatoes into blood, but remember it is dirty blood, because it is in a vein, not an artery. Before it can be made into good blood, and alive, it must be carried by the veins to the right side of the heart, through which all the dirty blood has to pass, flow through into the top room, and then run through the valve into the bottom room, where it will be squeezed or pumped through the pulmonary arteries into the lungs. When it gets to the lungs, if there is plenty of good air in the lungs, as there ought to be, some of the little corpuscles will be charged with oxygen, and away they will fly in the blood through the pulmonary veins to the left side of the heart, through which all the good blood has to pass, flow through into the top chamber, and pass through into the bottom room, where the blood will be pumped up into the big artery, the aorta, which will carry it to every part of the body in about half a minute. In the lungs, then, the last and most important part of digestion, or rather of the conversion of food into blood, takes place; for unless the lungs contain plenty of pure air, the chyle which comes from the food cannot be changed into good blood that will nourish the body. This is seen in a case of consumption when disease has injured the lungs. The patient may have a good appetite and eat the most nourishing food and still daily grow thinner and weaker. If people understood this important fact they would take care and have plenty of fresh air when they are taking their meals, instead of eating in hot crowded rooms filled with an atmosphere that has been breathed over and over again.

I must tell you a little more about these corpuscles. They

[1] I showed the veins in Marshall's diagram, No. 4, p. 40.

are to be found in the blood of all animals, but their shape is different in many animals. Our red corpuscles are round like a sixpence, but they are pressed down in the middle like an air-cushion. You can see them on this diagram.[1] The white corpuscles are much less numerous. I must take care to let you know how very small these little bodies are. You must remember they have to pass through those little hair-like tubes called capillaries, which are so fine that they cannot be seen without very powerful magnifying glasses. In a drop of blood there would be, it is said, about three million corpuscles —the same number as there are people in London, which is the largest city in the world. The corpuscles of a hen, fish, or reptile are oval, like that.[2]

Fig. 31.




*a*, three red blood-corpuscles from a frog ; *b*, two red blood-corpuscles from the monkfish, one seen edgeways ; *c*, two red blood-corpuscles of the common fowl ; *d*, three minute red blood-corpuscles of the goat ; *e*, human capillary vessel from the brain, showing its transparent skin, *s s* ; and also seven red and two white blood-corpuscles inside the capillary tube ; the white corpuscles are marked *w*.

When a murder has been committed, if a doctor examines a stain of blood on any clothes belonging to the murdered person, he may sometimes be able to tell by the size or shape of the corpuscles which he finds in the blood, whether it is blood that has come from a human being or a dumb animal. An old woman came to a hospital one day, and asked to be taken in, as her nose, she said, had been bleeding most violently. The doctor examined the handkerchief, and found it was covered with hen's blood. It proved that she was very

[1] Marshall's diagram, No. 4. [2] Marshall's diagram, No. 4.

poor, wanted to gain admittance to the hospital, and so had killed a hen and dipped her handkerchief in its blood.

*Things provided for the Lecture.*

A bottle of sweet oil.
One bottle with water and oil.
Some soda.
Marshall's diagram which showed the corpuscles and the organs of digestion, No. 4.
A picture of the stomach, bowels, and gullet (Marshall's diagram, No. 6).
On the blackboard I wrote *Mesenteric Glands, Corpuscles, Chyme, Chyle.*

*Questions for the Eleventh Lecture.*

1. If a person weighed 154 pounds, do you remember how much of that weight would be water?
2. Can any kind of food be digested or turned into blood unless it will mix with water?
3. Describe all you can remember about the way in which a dinner of solid food—beef and potatoes—is digested and turned into good blood.

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## LECTURE XII.

### *DIGESTION AND CARBONACEOUS FOODS.*

To-day I will first explain what is meant by animal and vegetable food. You will often meet people who will say, 'We are vegetarians; we never eat meat.' If you ask them if they never eat eggs, butter, milk, cream, cheese, they will say, 'Oh, certainly we do.' They forget that all these foods are most nourishing animal foods. The eggs we chiefly eat in England are those laid by hens and ducks; milk, butter, cheese, and cream we get from that most useful animal the cow. These are therefore all animal foods. Animal food means any food that has come from an animal.

What is vegetable food? It is anything that grows in the ground—grass, corn (which is ground into flour and made into bread), oatmeal, rice, potatoes, sugar, &c. Sugar is a vegetable food. In France they make all their sugar from beetroot; the sugar I hold in my hand is some I brought from France last autumn, which was made from beetroot.[1]

[1] I showed a beetroot.

There are, however, some animals which may properly call themselves vegetarians, such as the horse, cow, sheep, and elephant, because they never do touch animal food, and only eat vegetable food, such as grass, corn, or hay. When they are very young, it is true, they take animal food, because they take their mothers' milk. All animals which are fed by their mothers' milk when they are young are called mammals.

Young fish, directly they are born, eat what they can find in the water; many young birds eat insects. A chicken, the moment after it has stepped out of its shell, picks up anything it sees on the ground that takes its fancy, and eats it.

Don't you think it is very wonderful that an elephant, which is one of the strongest and largest animals that we know of, should be able to gain all its strength from vegetable food—grass and green twigs or boughs of trees—and that a child can also grow strong and have all its organs well nourished by only drinking milk? Milk is the only food an infant ought to have for the first nine months of its life.

Our bones are surrounded by two things, flesh and fat. We must therefore eat foods called 'flesh-formers,' that will make flesh and nourish our organs; and foods that will turn into fat, called 'body-warmers.' Here is a list of our 'body-warmers.' They are called 'body-warmers' because they contain carbon, which joins with oxygen and makes the heat that keeps our bodies warm.

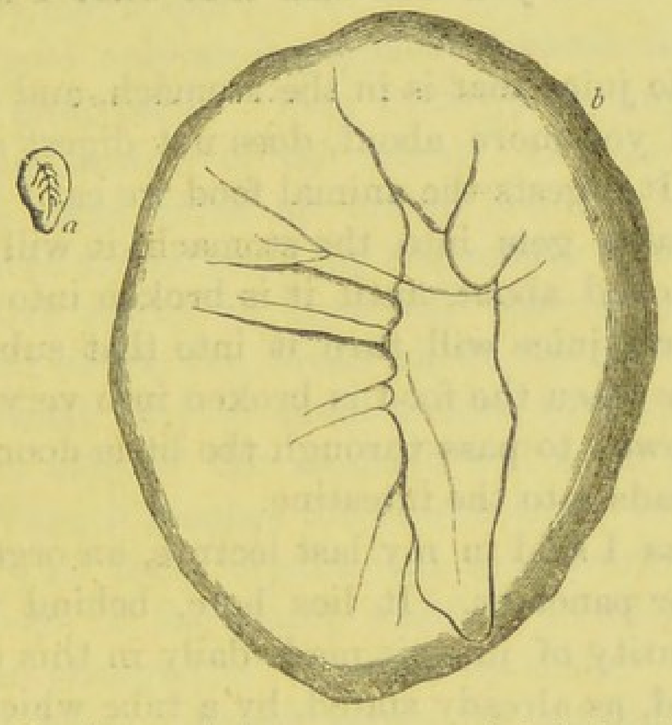
*Body-warmers.*

| Animal. | Vegetable. |
|---|---|
| Butter. | Sugar. |
| Dripping. | Treacle. |
| Suet. | Starch, which is in bread and all vegetables. |
| Lard. | Olive Oil. |
| Cod-liver Oil. | |

I want to show you in my next two lectures that the same substances that are found in animal foods can be found in vegetable foods. To-day I will try and prove that vegetables contain carbon.

Here is a piece of bread. In bread and all vegetables there is a great deal of starch. You all know what starch is, because you must have seen your mothers use it very often to make your fathers' shirts and collars stiff. If you could look at some starch through a magnifying glass you would see that it was made up of little grains. I have a picture here of one of the starch grains that are in bread.[1] In this tumbler there is some starch which our cook got from this wheat.[2] I will now pour some sulphuric acid on the starch, and you will soon see

FIG. 32.



*a*, Starch grain uncooked. *b*, Cooked and burst.

that the starch will become black like the carbon that is in this bottle.

I told you that no food we eat could be made into blood unless it would mix with water. Now, starch won't mix with water unless it nearly boils, and the water in our bodies is only warm—about 90° when people are well—while water does not boil till it reaches a temperature of 212°. Here is some starch.[3] It won't mix, you see; it falls to the bottom directly it is still. Sugar will mix perfectly or dissolve in water, as I will prove to you.[4] I will put this lump of sugar into this water. In a minute or two you would not be able to tell, unless you tasted the water, that there was any sugar in it. Fortunately the saliva, or spittle, in our mouths can also

[1] I showed a single cell.
[2] I showed the wheat in a tumbler.
[3] I showed some starch in water.
[4] I put some lumps of sugar in water.

change starch into sugar, which, I have just shown you, will mix with water.

Have you not often found a very sweet taste in your mouth while you were chewing some bread? You will now know the reason, because the saliva, or spittle, that is in your mouth changes the starch which is in the bread into sugar. Try a mouthful of bread this evening—don't eat any butter with it—and you will find that what I have told you is true.

The gastric juice that is in the stomach, and which I shall presently tell you more about, does not digest starch or oily substances. It digests the animal food we eat. When bread or any vegetable gets into the stomach, it will be churned, and gently moved about, until it is broken into little pieces, and the gastric juice will turn it into that substance called chyme. Only when the food is broken into very small pieces will it be allowed to pass through the little door on the right side, which leads into the intestine.

There is, as I said in my last lecture, an organ called the sweetbread, or pancreas. It lies here, behind the stomach. A great quantity of juice is made daily in this organ. This juice is carried, as already stated, by a tube which opens with the bile-duct into the duodenum. It is something like the spittle, or saliva, that is in the mouth, because it turns starch into sugar and helps to digest the vegetable food when it gets into the bowels. A great deal of the same kind of juice runs out of the glands of the intestines, so that the vegetable food continues to be digested the whole way as it passes through the bowels. The bowels of a man are about six times as long as his body. It seems scarcely possible that so long a pipe could take up so small a space as it does. Look at this picture.[1] Remember, the bowels are only one long pipe. All our organs are packed in the same beautiful way, so that not the smallest space is wasted.

Animals that eat only flesh, like the lion, have a very small stomach and very short intestines, or bowels: the lion's bowels are only three times the length of its body. A sheep has bowels twenty-eight times as long as its body; a horse,

[1] Marshall's diagram. See p. 83.

twenty times as long as its body. These animals only eat vegetables.

The reason of this is that a greater quantity of vegetable food is required to nourish the body. For instance, here is a pound of beef and a pound of bread. A hungry man could eat two pounds of bread. Two pounds of bread would make a very large quantity when digested. A pound of beef would go into a very small space.

Infants have only an imperfectly-formed saliva until they begin to cut some teeth. Very little juice comes out of the sweetbread or bowels of an infant. Let us see what will happen if a nurse gives an infant bread, or any vegetable food. As there are no teeth in the mouth to chop it up, and no very active saliva to turn the starch into sugar, the stomach must churn the bread about for an immense time in order to break it into small pieces, so that the little door on the right side of the stomach will open to let it pass through. When it reaches the bowels there will not be juice to digest it. All these organs will have worked in vain, because the bread, or the starch which is in all vegetables, will not have been changed or digested by them. The poor little creature will have suffered agony for nothing, as no blood will have been made to nourish its little frame.

Not long since I saw a child about a year old lying in a cot. Its face looked like that of a little withered old man, and its painful expression haunted me for a long time. I said to the grandfather, 'That poor little thing never gets any milk.' 'No; it doesn't like milk; it scarcely eats anything. This morning it had a good breakfast, because it fancied a bit of bacon, and took a good sup of raspberry tea.' It is true that if infants do not have milk they do not like it as they grow older, which is a very sad thing.

Mothers often say that they give their babies just what they take themselves. 'May-be some bread-and-butter or a potato.' When an infant is only two *hours* old many nurses even in this day will put a mouthful of butter and sugar into its mouth. Some years ago at St. George's Workhouse, London, it was said that every infant died before it had been in the house a year. All the children were taken care of by an old pauper woman. They were fed on bread—workhouse bread—soaked in water just coloured with milk. The children were placed in a row; then the old woman used to go along the row, and put into each child's mouth a spoonful of this soaked bread. In a very short time they all died. Indeed, they went into the 'house' to die.

Dr. Bednar, who lives in Vienna, was the surgeon to a foundling hospital some years ago, where poor little charity children are taken in. Dr. Bednar examined the dead bodies of fifteen of these poor little infants. He found that they had all been 'pined,' or starved, to death. There was scarcely any fat or flesh to cover their bones. The oxygen had burnt it all up. All he found was a great deal of starch lying along the bowels, which of course had not been digested. They too had been fed on bread-and-water.

This is the way babies are tortured and starved to death when mothers put their children out to nurse. The women, or baby-farmers, who earn a small sum of money for taking care of these children, cannot afford to buy milk, which is very dear, so they give them a great deal of bread-and-water. How dreadful it is to think that while these poor little creatures are suffering and dying by inches, or living to grow up miserable cripples who must work hard for their bread, their mothers are feeding rich women's children, and making them fat and happy. I do not consider that a poor ignorant mother who forsakes her child for money is half so cruel as the rich educated mother who, for the sake of ease and pleasure, refuses to feed and cherish her little one. Until mothers will be really mothers to their own infants, and give up the fashionable and unnatural practice of engaging wet nurses, a country, though it may be called civilised, will never produce a moral and healthy people. It is stated that the more civilised a country becomes, the more infants die every year. In England about half the children born die before they reach five years. Milk, and only milk, is the food for children for the first six or nine months. If there is no mother's milk, an infant, with care, may be brought up very well on cow's milk, not *skimmed* milk. After eight or nine months the milk may be thickened with a little baked flour (not corn-flour). Bake the flour in a cloth until it is hard, not burnt, and then scrape off as much as is required to thicken the milk. A great deal of milk should be given to every child until it is *seven* years old, mixed with flour, rice, tapioca, semolina, &c. Some milk should be given at every meal. Swiss milk suits some infants, but it cannot be so good as milk that has come fresh from a cow or an ass.

*Things provided for the Lecture.*

A picture of a starch cell.
Some starch got from wheat and the wheat from which it was taken.
Sugar and water.
Marshall's diagram of the viscera, No. 3.
A piece of beef and a piece of bread.
Experiment to turn the starch into carbon.

*Questions for the Twelfth Lecture.*

1. Write down the names of some of the animals which have all the organs a human being has, and which eat nothing but vegetables.
2. There is a great deal of starch in bread and all vegetables. Into what does the spittle that is in the mouth change the starch?
3. Are vegetables changed, or digested, in the stomach?
4. Why are the bowels of a sheep twenty-eight times longer than its body, and a lion's only three times longer than its body?
5. Why is it impossible for a baby to change bread or any vegetable food into good chyle and blood until it has cut some teeth?

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## LECTURE XIII.

### *CARBONACEOUS AND NITROGENOUS FOODS.*

I could not tell you in my last lecture all I wished to say about carbonaceous foods, which I called 'body-warmers.' You had better write down the long new name, as you will find it is the name generally used in books. The reason they are called carbonaceous foods is because they all contain a great deal of carbon. Sugar and treacle contain a great deal of carbon. This I will prove to you by two little experiments. Here are two tumblers; one contains treacle, the other sugar. I will pour some sulphuric acid into both the tumblers. You must notice that the sugar and treacle are quite cold before I put in the acid. A little boy and girl had better come to me and feel how cold the tumblers are. I will pour some of this acid into both the tumblers. You see both the treacle and the sugar have become as black as a piece of charcoal or this carbon I have in this bottle, and a very great amount of heat is made.

Sugar and treacle contain three things—oxygen, hydrogen, and carbon. All this great heat which you see is made because the sulphuric acid has joined *chemically* with the oxygen and hydrogen that are in the sugar and treacle. Sulphuric acid does not like carbon, so the carbon is left all alone in the tumbler.

Heat, you must remember, is always made when two things join chemically together. Sugar and water do not join chemically. The sugar is only melted in the water; it does not join with either the oxygen or hydrogen that the water is made of.

The reason why I am so anxious to make you understand that sugar and treacle are 'body-warmers' is because these two kinds of food are very good for children. They ought to have plenty of them at their meals, if they like them. Little children have to grow tall as well as strong; this they cannot do unless they have plenty of fat to cover their bones. It often happens that children do not like the fat that comes from an animal, such as mutton and beef fat; but they nearly always like sugar and treacle. These two things turn into fat when they are digested in the body. They can eat them instead of animal fat. I do not believe that children would all have so great a longing for sweet things unless sweet things were good for them.

It has been generally thought that sugar is not wholesome, and that it injures the teeth. To prove that this is a mistake we have only to go to the West Indies, where the sugar-cane grows, and see how healthy and fat the little black children are. It is not possible to see children who have whiter or stronger teeth than they have. Fortunately sugar is now very cheap in England, as the tax has just been taken off. It is, no doubt, a very bad thing to let children eat a great many bought sweets, or goodies, because they are very often not made of good sugar, and are coloured by poisonous matter. These goodies are generally eaten between meals, and spoil the appetite. Eating between meals is a very bad habit for persons of all ages. I have only one thing more to tell you about carbonaceous food. It is that all body-warmers, both animal and vegetable—namely, starch, fat, sugar, treacle—are made of only three things: carbon, oxygen, and hydrogen.

You are now going to hear about the foods which make our flesh and forty organs. A list of them is written down on that sheet. I will read them over to you.[1]

*Flesh-formers.*

| Animal. | | Vegetable. | |
|---|---|---|---|
| Meat. | Game. | Flour. | Rice. |
| Fish. | Eggs. | Oatmeal. | Peas. |
| Poultry. | Cheese. | Barley, Rye. | Lentils. |

All these foods contain *four* things—oxygen, hydrogen, carbon, and nitrogen.

Nitrogen is a gas I have never told you about before, because all the foods called 'body-warmers,' that make fat, have none of this gas. There is a great deal of it, however, in the air. The air is chiefly made up of nitrogen mixed with oxygen, of which you have already heard so much. All foods that make flesh must have nitrogen, and are therefore called 'nitrogenous foods.'[2] All animal and vegetable flesh-formers contain a substance called albumen. This is a most important substance, as it is with the help of albumen that all our nerves, as well as our flesh or muscles, are made.

I will first show you some animal albumen: the white of an egg is albumen; an egg is animal food. I have broken an egg and put it unboiled into this glass bottle, so that you may all be able to see, when I hold it up, that it contains a white

[1] I showed a table of flesh-formers.

[2] I wrote this on the blackboard.

and a yellow part. The white part is a sticky, gluey substance. I will stick these two pieces of paper together with this white of egg. Here is another bottle, in which there is some vegetable albumen. It has come from the same flour you saw at the last lecture, out of which our cook got the starch. It is also very sticky. I will stick these two pieces of paper together with it. The albumen that is got out of vegetables is called by another name, though it is the same substance—viz., gluten—from its sticky nature.

When a person cuts his flesh, the variety of albumen, called fibrin, that is in the blood comes out of the wound, makes a clot of blood, and fastens its sides together. If there was no fibrin in the blood, the cut or wound would never stop bleeding. I will tell you more about albumen and fibrin in my next lecture.

So far I have only described the way in which solid foods are digested, because liquid foods—such as wine, and spirits, and water—are not digested in the stomach or bowels; they all only pass through the stomach to the liver. The liver is the largest organ of the body. It weighs from fifty to sixty ounces. When you drink any liquid, it goes down the gullet and into the stomach. It then runs through the coats of the stomach into little pipes, which carry it to a big vein which opens into the liver. All the blood that goes to the liver is dirty blood, and it is out of this dirty blood that the liver makes a great many things, the most important of which are bile and sugar. Sugar is one of the forty things that the blood, to be healthy, must contain, and the liver makes the greater part of the sugar the blood requires.

In the liver the liquids get taken into the blood, and the blood is poured into the great vein, called the lower vena cava, which carries all the dirty blood to the heart. Thus the liquids which we drink reach the heart very quickly. This is the reason why a cup of wine immediately revives a person whose heart is weak. Solid food, such as meat and vegetables, generally take about three hours to digest.

I dare say you often hear your parents or friends say that they feel bilious. Biliousness is often caused by taking too much fat or carbonaceous food. Fat is not, as you know, digested in the stomach; it is digested in the intestine called the duodenum. If there is not bile enough there to change the fat into a soapy substance, the fat remains in the liver.

There is a most expensive dish sold in Germany called *pâté de foie gras*, the English of which is 'patty of fat liver.' I will tell you how it is made. A live goose is fastened down to a board, and put very near a fire or stove. It is fed on oily food, and it is allowed no fresh air or exercise. After a time its liver grows big and fat and diseased. Then the poor goose is killed, and the liver is made into a pie, or potted. A small pot is sold for three or four shillings, and is considered a great treat. I am very glad to say that this dish, which is so cruelly procured, is most indigestible stuff.

Doctors say that plenty of fresh air and exercise is the best way to prevent biliousness. Good water helps the liver to make bile. Footmen—gentlemen's servants who live in grand houses, sit a great deal in warm rooms, eat rich, fat food, drink beer instead of water, and do very little work such as strong men ought to do—suffer very much from liver complaints.

There is a dreadful complaint called a nutmeg liver. The liver all shrinks up and becomes like a nutmeg. This is the kind of liver a man has who drinks spirits; this is called a drunkard's liver.[1] I will tell you in the next lecture the bad effect that spirits have upon the liver.

*Things provided for the Lecture.*

Sugar.
Treacle.
A bottle of carbon.
Some sulphuric acid.
A raw egg in a large clear glass bottle.
Some pieces of paper to stick together.
Some gluten in a bottle.
Two experiments, turning sugar and treacle into carbon.

*Questions for the Thirteenth Lecture.*

1. Why are all kinds of oil, fat, sugar, treacle, and starch called 'carbonaceous foods,' or 'body-warmers?'

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[1] I showed a picture of a nutmeg liver.

2. Why is it good to give children sugar or treacle at their meals if they like these foods?
3. What is the name of the gas that must be in all foods called 'flesh-formers,' which make our forty organs and strengthen our muscles and nerves?
4. When we drink anything, through what organ must that drink pass?
5. Why do drunkards and footmen suffer very much from liver complaints?

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## LECTURE XIV.

### *NITROGENOUS AND LIQUID FOODS, AND THE HARM SPIRITS DO TO OUR ORGANS.*

My lecture to-day will again be about liquid foods. I had better mention that I am not a pledged teetotaller. I do not take wine or any stimulants, because I think it is not right to do so, as I am strong and well. I shall now try to explain some of the harm that spirits do to our organs, and to that substance which feeds our nerves called 'albumen.' Great heat also injures albumen. For instance, here is an egg that has been cooked in boiling water. You see the white part, which is albumen, has become very hard. When it is in this state it will take more than three hours before it can be digested. This other egg has not been cooked in boiling water; the albumen, you see, is soft and creamy, very different from that hard albumen. It will digest in two hours, and will strengthen the nerves much better than the albumen would do which is in that hard-boiled egg.

There is something written down on the blackboard about albumen, which you must copy. It is as follows:—'Albumen becomes hard and indigestible when it is cooked in water that is at 212°, which is boiling-point.' At the end of the lecture I will send this thermometer round, for you to examine it and see that 212° is the boiling-point.

I am now going to tell you about the injury spirits do to our different organs. Drunkards suffer very much from stomach as well as from liver complaints, because all the liquids that we take have to pass through the stomach before they get to the liver.

You will perhaps wonder how it is that doctors have been able to find out how food is digested in the stomach, and how they know the number of hours different foods take to digest. They gained a great deal of this information by an accident that happened in America to a Canadian, called Alexis St. Martin, about forty years ago. He was shot by a buck shot; the shot went through his stomach, and left a hole so large that Dr. Beaumont, the celebrated physician who attended him, could see all that went on in his stomach for several years. The accident happened on June 6, 1832. Alexis St. Martin would not allow the opening to be closed, as it did not affect his health. He enjoyed excellent health, and his digestion went on as regularly as if no opening had ever been made. He remained as a domestic servant with Dr. Beaumont for some years. Directly he took brandy, or any kind of spirit entered the stomach, the beautiful pink membrane lining the stomach, which I have described to you, became very red. When spirits had been taken for a few days sore boils appeared. The gastric juice seemed dried up, so that the meat could not be digested. The albumen, or gluten, became hardened, just as if it had been cooked in boiling water. Directly St. Martin gave up spirits the boils went away, the proper quantity of gastric juice came out of the stomach, and his digestion was all right again.

I will now tell you all I know about the harm spirits do to different parts of the body. I told you it injured the liver and made its substance very hard; and spirits also cause a fatty change in the muscles, so that the healthy substance of the liver and the fibres of the muscles gradually become changed into a kind of fatty substance, and are thus rendered useless. When spirits enter those wonderful little hair-like tubes called capillaries, it is said that after a time their delicate coats are thickened. Of course this prevents the good blood from passing freely through them into the surrounding parts to feed the flesh and different organs; and the old materials from entering the capillaries, to be carried by the veins to the right side of the heart, that holds the dirty blood. For a short time, it is true, the blood is made hotter by spirits. This heat makes the heart work more quickly and send blood to every part of the body more rapidly. But this heat soon dies away, and the blood becomes colder than it was before the spirits were taken. We learn this fact from Arctic travellers—men who have spent many months in countries where there is nothing but ice and snow. They dare not take spirits there, because it makes them colder after a time. They find they can only keep up the heat in their bodies by eating foods that contain a great deal of carbon, such as oil or fat, which are very properly called body-warmers. There is a complaint called fatty degeneration of the heart. In this disease the muscles of the heart turn into fat, and therefore cannot do their work.

The albumen and fibrin are also hardened by spirits. I dare say you have seen men who drive brewers' carts, loaded with barrels of beer, which they leave at people's houses. These men are called draymen. They are generally very fine, fat-looking men. In London, as a rule, they drink an immense quantity of beer, which contains spirit. Though they look so healthy they are really not so, because if they cut their flesh very slightly the wound will not heal, and they often die in a few hours after the accident. A woman who came to hear my lectures told me that a friend of hers had married a drayman. He came home one evening with a small cut on his arm. The place began to swell, and he was dead by the morning.

You see I have some blood in this bottle that came from an ox; it is the same as human blood. The blood has separated into two substances; the thick part is called a clot, and the thin white part is called serum. The clot, which is the thick part, contains albumen, fibrin, and red corpuscles, those little bodies that carry the oxygen gas. After a bad fever—typhus, for instance—the blood becomes poor; it will not form into a clot. When the blood is in this state, should the nose or any part bleed, the bleeding cannot be stopped.

This hard substance in this bottle is a clot of blood that has been preserved in spirits. It has become almost as tough and hard as a piece of leather. The doctor at the Schoo Medicine kindly lent it me.

Persons who drink hard often suffer from delirium tremens, which is the most awful complaint that can befall a human being. The nerves of those who have this disease are so weakened that they tremble like a leaf at the slightest sound. The mind becomes full of dreadful thoughts. They see, or fancy they see, horrid sights. Sleep brings no rest or comfort, only fearful dreams, from which they awake in such an agony of fear, that though they are afraid to live, they are still more afraid to die. Hunger they never know, only a constant thirst for the poisonous drink that has reduced them to a state much lower than that of the beasts in the field.

If spirits have such a fearful effect on the nerves of a strong man, what must their effect be on the delicate nerves of an infant? I am grieved to say that it is a common practice of mothers to give their babies gin. This spirit causes a constant thirst. A mother could not, therefore, choose a more cruel drink, because an infant cannot say it is thirsty. It is believed that gin stops the growth of all the organs. I dare say you have seen at the Leeds fairs, or feasts, little boys and girls dancing in front of shows, or tumbling and doing all kinds of wonderful feats in a ring. Their masters, it is said, give them gin to keep them small and young-looking. They also keep them up late at night, which is another sure way of making children small, delicate, and unhealthy.

I have told you a great deal about the drinks which man has invented for himself, such as wine and spirits. I will now tell you something about the two drinks that God has provided for man: they are milk and water. Water is the most important of all foods. A man might be kept alive for weeks if he took plenty of water and no food, but he would die in a few days if all water were withheld from him.

A cup of cold water is the most cooling and refreshing drink you can give a person who is suffering from the thirst of fever; the blood then becomes too thick, because the great heat has dried up the water the blood ought to contain. The water we drink soon grows as hot as the blood, and turns into vapour, which opens the pores of the skin and carries off the heat in perspiration. Spirits dry the skin and shut up the pores. Dr. Edward Smith says that a man while he is drunk does not perspire. No wonder he becomes so mad and delirious. I hope you will explain how water cools the blood to anyone who thinks it is a bad thing to give water in case of fever.

I have been often told that parents do not think it safe to give their children as much water as they want when they have a fever or are thirsty. It is always a safe drink; even a baby would not be hurt by it. The blood will only contain a certain amount of water, however much you drink. It is dangerous to drink cold water after violent exercise; but not at all dangerous to drink it during the exercise before the body has begun to cool. If you have been running very hard on a hot summer's day, and feel very thirsty, then you had better take a little water from time to time until your thirst is gone. When people suffer from a continued thirst, tepid water lessens it better than cold water. A piece of ice in the mouth is a good thing. Snow, unless it is melted first, increases the thirst: this is a very strange fact.

Now I must say a few words for poor dumb animals, who, like little babies, cannot speak for themselves. I am afraid they suffer dreadfully from our cruelty and ignorance. It is considered by many people very bad to let a horse drink when it is thirsty, as they say that it should only be allowed to take water at certain times. All sensible masters and grooms place water in the stables, and let the horses drink when they feel inclined. A horse, donkey, dog and cat require a little water often, as they have smaller stomachs for their size than we have. A donkey is very particular that the water he drinks should be clean and pure, because in the country he comes from he is accustomed to drink from clear running streams. Drinking-fountains, I am glad to say, are generally put up in all large towns, so that horses, if their masters will let them, can drink when they are thirsty.

Every fountain ought to have a place put low down, so that sheep, dogs, cats, and other small animals may be able to satisfy their thirst. It is a very cruel practice to put muzzles on dogs, that shut up their mouths and prevent them from drinking and from putting out their tongues.

Dogs perspire chiefly through their tongues and mouths; very little sweat comes out of the pores of their skins. You must all have noticed on a hot day that dogs let their tongues hang out. When they are running fast they only breathe freely when the mouth is open and the tongue out, as their nostrils are rather small. When muzzles are considered necessary, they should be made of wire, and large, so that the mouth can open. The best way to make a dog go mad is to strap up its mouth with the kind of muzzle generally used in England.

*Things provided for the Lecture.*

Fresh clot of an ox's blood.
A clot that has been kept in spirits, from the School of Medicine.
A hard-boiled egg and a soft-boiled egg.

*Questions for the Fourteenth Lecture.*

1. What part of an egg is albumen?
2. Tell me all you can remember about the harm spirits do to the following organs: stomach, gastric juice, liver, capillaries, heart, muscles, nerves; and why it is very cruel to give a baby any kind of spirits, particularly gin.
3. Why is water the most cooling of all drinks, and may be safely given to children and dumb animals, particularly dogs and cats?
4. Why is it dangerous and cruel to put a muzzle on a dog that will prevent it from drinking and from opening its mouth?

# LECTURE XV.

## *MILK AND MINERAL FOODS.*

New milk is a body-warmer and a flesh-former, and contains everything the body requires. It is digested in two hours.

The following things are contained in one pint of cow's milk and in one pint of mother's milk :—

| | *Cow's Milk.* | *Mother's Milk.* |
|---|---|---|
| Water . . . . . | 13 oz. . . | 14 oz. |
| Flesh-former . . . | $\frac{3}{4}$ oz. . . | less. |
| Body-warmer . . . | $1\frac{1}{4}$ oz. . . | more. |
| Phosphate of lime, potash, and other salts | $\frac{1}{2}$ oz. . . | same. |

Before I say anything about the wonderful properties of milk, I must tell you that our forty organs are like forty machines, which will get out of order unless they are used regularly. The gastric juice that comes out of the stomach, the pancreatic juice that comes out of the sweetbread, the intestinal juices—that is, the juices that come out of the skin lining the bowels—the bile, are all fluids by means of which solid foods are digested.

If we do not eat solid food, these fluids will gradually become less and less, just as the so-called joint-oil slowly goes away from joints which are not used. If, on the other hand, we take too much liquid food, we shall give the organs that digest liquid food too much work to do, and they will get out of order, and will soon be worn out.

It is very bad for grown-up people to take only liquid food; you will wonder how it is possible that a baby can live on nothing but milk for the first year of its life, for milk appears to be a liquid food. I will explain how some of the milk we drink always becomes a solid food in the stomach. Here is some gastric juice which was taken from the lining skin of a calf's stomach after it was killed. It is exactly the same kind of gastric juice as that which comes out of the stomach of a human being. I will put some into this tumbler, and you will see at the end of my lecture that about half the milk has been turned into a solid substance called 'curd,' and the other half into a liquid called 'whey.' The curd, or thick part, is the same substance as cheese. Farmers make cheese by putting some of this gastric juice, called 'rennet,' into milk. The curd is pressed by weights until it becomes a solid cheese, and the whey runs out. Cheese is a nitrogenous food and an animal flesh-former. If cheese is made from new milk, it contains less water and more nourishment than beef and mutton. New milk is milk, you know, that has had none of the cream taken away from it.

Some people make cheese of skimmed milk—that is, milk that has had all the cream taken from it. This is very poor cheese—so poor that dogs, when they see it, bark at it, pigs grunt at it, but neither the dog nor the pig will bite it. This kind of cheese is made in Suffolk and Wales.

A mother's milk is new milk. If a baby gets its mother's milk, its rightful food, the curd that forms the solid food in its stomach will be of the richest.

An infant's liver is very large when it is born, but afterwards, as the child grows older, and takes more solid food, it does not grow so fast as many other parts of the body. Nurses have a practice of bandaging a baby very tightly round its body. This squeezes up the liver. Several working-women have told me that they have gone into a cottage where a baby was screaming, and found that the poor little creature had been bound up so tightly that the flesh was all in wrinkles. The crying ceased when the bandage was made loose. Here is a picture showing the organs that are thrown out of place when the body is bound tight in that way.[1] A piece of flannel put once round and tied with strings is quite enough.

I have proved to you that milk contains a solid nitrogenous food, which forms flesh, muscles, &c. I have still to prove to you that milk contains carbonaceous foods, or 'body-warmers,' that will form fat. The cream that stands at the top of milk is of an oily nature, and is therefore light and floats on the top.[2] You know how butter is made: the cream

[1] I showed Madame Bodichon's diagram. See p. 33.

[2] I showed a glass of new milk.

is taken off and put into a round barrel, called a churn, and moved about until it is made into butter. Butter contains a great deal of carbon, and is therefore a body-warmer. If you were to feed a baby only on cream, it would soon pine to death. All its organs would waste away. When dogs have been fed on nothing but fat, they have died after a few weeks. If you were to feed a baby on skimmed milk it would also probably pine to death in time, because, though skimmed milk retains all the sugar of the milk, which is a body-warmer, that would not be sufficient, and the fat in its body would be burnt away by the oxygen that passes into the blood through the lungs. Some mothers and nurses think they are giving a baby the best and most nourishing food when they let it drink cream; instead of nourishing the child, they are starving it to death. Nothing but new milk will nourish it properly.

We must all eat body-warmers and flesh-formers. One kind of food will not feed us. It is curious to think that a human being or a dumb animal may be pined to death though they are eating food all day long. The men who went to discover the great plains of South America were pined to death in this way. They could get plenty of food of one sort, but they died off one by one because they could not procure both body-warmers and flesh-formers. You will now have learnt by my lectures that it is necessary that we should take both solid and liquid foods, and that we should also eat foods that contain nitrogen gas and a substance called carbon.

There is still another kind of food which I have to describe, that we must have to purify our blood, called mineral food. I have written down on the blackboard some of the principal mineral substances blood ought to contain—iron, sodium, lime, potassium. Minerals include all solid bodies found in or on the earth that are neither animal nor vegetable. You will often read in books and hear people talk about the salts that are in the blood. These salts always contain a mineral and a gas. These two substances must be united chemically, not just mixed as sugar is mixed in water.

I am going to tell you a great deal about salts, as there are several in the blood. To-day I shall only tell you about one which is called potash. I have some in this bottle, which you see is a white substance. It is composed of a metal called potassium and oxygen gas. I will make a small quantity of this salt at the end of the lecture. At my next lecture I will make another salt, called soda. You all know, I am sure, the name of this salt, and must often have seen some at home.

A hundred years ago there was a dreadful complaint called the scurvy, that killed nearly all our sailors who took long sea-voyages. In those days the voyages were very long, for they had only sailing-vessels, no steamers. It took six months to go to India (now it takes six weeks) by sea. The food these poor men had to eat and drink for nine months at a time consisted of salt meat, hard biscuits called sailor's biscuits, no bread, bad water, *and plenty of spirits.* They never touched fresh vegetables, such as potatoes. Now, in potatoes and all green vegetables there are salts of potash and lime, and several others, which the blood must contain to be pure.

Before the Irish famine, which was caused by the failure of the potato crops, the Irish people used to live almost entirely on potatoes. During that time, as they ate plenty of potatoes, they did not know what it was to suffer from this dreadful complaint called the scurvy, but directly they had to eat salt meat without any vegetables they had this complaint

Dr. Guy, a physician who, I am glad to say, is now living, has written a most interesting book,[1] in which he gives the following description of the dreadful sufferings our sailors had to endure when they were so shamefully fed at sea 100 years ago:—'Round blotches came under the skin, called "purples." The blood ran into the flesh and made the limbs painful and stiff. The blood-vessels were so weak that they broke with a touch. The gums swelled and became dark. The teeth grew loose and fell out of their sockets. The breath was bad, and blood poured from the nostrils and eyes. The poor sufferer became so weak that he fainted at the least exertion, and fell down dead in sight of his native land.'

A ship under the charge of Captain Anson left England with a great many sailors. When Captain Anson returned

[1] 'Public Health: a Popular Introduction to Sanitary Science,' p. 142.

from his voyage in nine months, he had lost 626 of his men. I hope you have all heard of Captain Cook, who was the first man to sail round the world. I am delighted to tell you he was a Yorkshire man. He lived at the same time as Captain Anson. His father was a labourer, and resided at Whitby. You see he was the son of a working-man. Captain Cook was not only very clever, but very kind-hearted and good. He could not bear to see men suffer: he therefore determined to find out how scurvy could be prevented or cured. He soon saw that where people had plenty of fresh vegetables they did not have scurvy. He could not take enough potatoes on board his ship to last a great many months, but he could take lemon juice, which happens to contain a great deal of potash. He also sent the sailors on shore whenever it was possible, so that they might eat any fruit or vegetables they could find. By this means he kept his sailors in good health. After a voyage of three years he returned to England, having only lost four of his men. I hope you will all some day read the life of this good man. There is a small Life sold for a penny, which you can get at Wood's, the bookseller in Market Street, Leeds.

I will now show the experiment by which the salt called potash is made. This salt is made of a metal called potassium and a gas called oxygen. I have some water in this tumbler. Water, you know, is made of two gases, oxygen and hydrogen. I will take a small piece of potassium out of this bottle and put it into the water. The potassium is so fond of oxygen that it will join chemically with the oxygen that is in the water, and burst into a flame. You may always know when two or more substances have joined chemically, because heat is made and also a new substance is formed. When the oxygen gas and the metal potassium united, a great deal of heat was made—because you saw the flame. If we look at the bottom of the glass, we shall find that a new substance has been made—potash. Here it is. This white stuff is potash, the salt that is found in the greatest quantity in potatoes. There is also a great deal of it in all green vegetables, such as lettuce, cabbages, and in all kinds of fruit—oranges, &c. Lemons contain the most potash, and that is the reason why the lemon juice Captain Cook took in his vessel, and gave to his sailors, did them so much good.

### *Things provided for the Lecture.*

Some gastric juice from a calf's stomach.

Two tumblers of new milk.

A small packet of soda.

Some potassium.

Madame Bodichon's picture of the organs of digestion displaced by lacing.

Some water.

Some potash in a bottle.

### *Questions for the Fifteenth Lecture.*

1. Why would an infant, a grown-up person, or any animal be pined to death if they were fed on nothing but cream or any of the carbonaceous foods called 'body-warmers,' and why would they also be pined to death if fed only on 'flesh-formers,' or nitrogenous food?
2. Why is it necessary that some of the food we eat daily should be solid food?
3. Why is it very wrong to bind an infant's body with anything that is in the least tight?
4. What dreadful complaint did our sailors suffer from about a hundred years ago, and who was the man who discovered how to cure it?
5. Name some of the chief vegetables that contain the most potash.

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## LECTURE XVI.

### *MINERAL FOODS (continued).*

I PROMISED at my last lecture that to-day I would make a salt called soda. I have a piece in my hand; you see it is the same soda your mothers use on washing-days. There is a great deal of soda in soap; that is the reason why washer-women use a great quantity when the clothes are very dirty. Soda takes out the dirt directly; but, as it also takes out the colour of clothes, it ought only to be used in washing coarse white materials, or materials that soda does not spoil, for it does not spoil all coloured things.

Soda is composed of a metal called sodium and oxygen gas. I have some sodium in this bottle; I will put a small piece of it into this tumbler of water. Directly it touches the water, which you know is partly made of oxygen gas, it will unite chemically with that oxygen, and there will be a great amount of heat given off. A new substance will, of course, be made by this union, and it will fall to the bottom of the tumbler. I am afraid there will be so small a quantity that it will be scarcely visible. Soda is, like potash, an alkali. I must now explain what an alkali is. I have some water in this glass which is very acid. I should like one or two of you to come and taste it. If the water is acid, it will make this piece of blue paper turn red, because all acids turn certain vegetable blue colours red. Now I will put some soda into this acid water, and you will find afterwards that no acid taste will remain, because the soda is an alkali, and takes away the acidity. Some salts are alkalies.

When our food is being digested in the stomach it is all made very acid by the gastric juice. After this acid food passes a good distance down the intestine, it is said that it becomes alkaline, partly owing to the pancreatic juice, and partly to its admixture with the bile, but chiefly owing to the juices from the intestine itself.

I will just mention a few salts whose names you know. Salt that we eat is a salt. It is made of a gas and a mineral. Sodium is the mineral, the same one that is in soda. The name of the gas you have never heard; it is called chlorine gas. There are many different kinds of gases. I have only told you during my lectures about four gases—oxygen, hydrogen, nitrogen, and carbonic acid gas. People cannot live unless they can have the salt called salt. In some countries persons used to be tortured to death by not being allowed to have any salt either in their food or to eat.

The hard part of all our bones consists almost entirely of a salt called phosphate of lime. I have some of the phosphate of lime in this bottle. This soft bone I hold in my hand[1] is so soft because all the phosphate and carbonate of lime have been taken out of it; all that is left of the blade-bone is only gelatine, the same stuff we make jelly of. Here is some gelatine in this packet. Bread contains more of this salt—phosphate of lime—than any other food. That is why boys and

[1] I showed a blade-bone from the School of Medicine.

girls who are growing ought to eat a great deal of bread. Farmers put all the old bones they can get on those fields in which they sow wheat. The heat of the sun separates the lime and phosphorus, which with oxygen make the salt called phosphate of lime, from the gelatine. The lime and phosphorus then sink into the earth, and nourish the wheat while it is growing, and we eat these two substances again when the wheat is ground into flour.

You must remember that heat makes things join together chemically, and that heat can also separate them. Great care should therefore be taken by the cook to prevent the heat being so great that it will injure the substances contained in food. I told you that vegetables and fruit contained a great quantity of potash. We can eat a great deal of fruit without cooking it, such as apples and oranges, and also a great many green vegetables which we make into salad, such as lettuce, mustard and cress, onions, &c. In France they eat a great quantity of salad all the year round. Water in which vegetables have been boiled contains a great deal of saline matter. This water ought to be used for soups, and not thrown away.

During the next few lectures I intend to tell you how food ought to be cooked. So you must remember all I have just been saying to you. Our blood requires a great many minerals as well as salts, such as iron and magnesium. One reason why people lose their colour, and grow very pale and white, is because they do not get enough iron. We get a great deal of mineral food in the water we drink. This water comes from rivers and springs, and as it runs along over and through the earth it dissolves the minerals that are in the soil, just as sugar dissolves in water. The clearest water often contains a great many substances, both good and bad, which we cannot see with the naked eye. Some iron has been dissolved in this water, though it looks quite clear.

I dare say some of you have been to Harrogate and tasted the Harrogate waters. There are iron and sulphur wells there. People who suffer from skin complaints go to Harrogate on purpose to drink these waters, to make their blood pure. Very likely if these invalids had understood what the blood requires, and had eaten the right kind of foods, they would never have suffered from an unhealthy skin.

It is just a hundred years since Dr. Priestley discovered oxygen gas. Before that time everybody thought that water was an element—that is to say, one thing only. They did not dream that it was made of two gases. They also thought the air we breathe was an element.

Our bodies, I have before told you, contain an immense quantity of water. You know, if a man weighs 154 pounds, 111 pounds of that weight will be water. Where do we get this great quantity of water from? No wise person in health drinks more than from two to three pints daily of any liquid. A pint is equal to a pound and a quarter. I will read over this food table, and then you will know where we get nearly all this great quantity of water from.

The following list will show how much water there is in animal and vegetable foods.

(Sixteen ounces make one pound.)

| Hours to Digest | One Pound of | Contains of | | | |
|---|---|---|---|---|---|
| | | Body-warmers | Flesh-formers | Water | Ashes |
| 3½ | Bread . . . | about 10 oz. | about 2 oz. | about 4 oz. | about ¼ oz. |
| 4 | Meat . . . | ,, 3 ,, | ,, 3 ,, | ,, 10 ,, | ,, ¼ ,, |
| 3½ | Cheese . . . | ,, 4½ ,, | ,, 5½ ,, | ,, 5½ ,, | ,, ½ ,, |
| 2 | Milk . . . . | ,, 1 ,, | ,, ½ ,, | ,, 13½ ,, | ,, ½ ,, |
| 3 | Eggs . . . . | ,, 1½ ,, | ,, 2½ ,, | ,, 12 ,, | |
| | Butter . . . | ,, 14 ,, | None | ,, 2 ,, | |
| | Suet . . . . | ,, 14 ,, | A trace | ,, 2 ,, | |
| | Dripping . . | ,, 14 ,, | None | ,, 2 ,, | |
| | Oils . . . . | ,, 14 ,, | ,, | ,, 2 ,, | |
| | Lard . . . | ,, 14 ,, | ,, | ,, 2 ,, | |
| | Loaf Sugar . | ,, 14 ,, | ,, | ,, 2 ,, | |
| | Arrowroot . | ,, 14 ,, | ,, | ,, 2 ,, | |

DRY FOODS.

(Grains, Seeds, &c.)

| | | |
|---|---|---|
| Wheat. | Peas. | Semolina. |
| Oats. | Rice. | Macaroni. |

In one pound of these there are about 1½ oz. of water.
12 ,, ,, fat.
2 to 3 ,, ,, flesh-formers.
¼ ,, ,, salts and minerals.

## WET FOODS.

(All Green Vegetables and Fruits.)

| | |
|---|---|
| Potatoes. | Apples. |
| Turnips. | Oranges. |
| Carrots. | Gooseberries. |
| Onions. | Currants, &c. |
| Lettuce and all kinds of salad. | Lemons. |
| Rhubarb. | Pumpkin. |

*Chiefly given to feed Dumb Animals.*

| | |
|---|---|
| Linseed. | Grass. |
| Rape seed. | Clover. |
| Lentils. | |

In one pound of these there are about

| | | | |
|---|---|---|---|
| 12 oz. to 14 oz. | of | water. |
| 2 | ,, | fat. |
| 1 | ,, | flesh-formers. |
| $\frac{1}{2}$ | ,, | salts and minerals. |

You see that every kind of food contains a great deal of water. The reason we suffer from thirst is because our blood does not contain enough water, or else contains too much saline matter; we must either have eaten very dry salt foods or have perspired a great deal. In hot countries people perspire much more than they do in cold countries. They must either drink a great deal of liquid or they must eat food that contains a great deal of water. Taking a bath relieves thirst. There is a great deal more water in moist vegetable foods, such as potatoes, fruit, &c., than there is in animal food. People eat a great deal more vegetable food in hot countries than they do of butcher's meat and other animal food. Pumpkins contain a great deal of water, as much as fifteen ounces in every pound. They grow in very hot countries in the middle of sandy deserts where water is seldom to be found. A gentleman who had both seen and tasted a pumpkin told me that it looks like a big melon, and that when you open it nothing but clear water runs out. How thankful travellers must be to find this fruit growing in the middle of a desert. Grains and seeds, you see, have very little water compared with vegetables and fruit.

I have in this bottle the quantity of water—$1\frac{1}{2}$ ounce—that can be taken out of a pound of wheat. In this bottle I have the quantity of water—14 ounces—that can be taken out of a pound of potatoes. No wonder the poor Irish people were not thirsty when they lived chiefly on potatoes. When the potato crops failed they were obliged to eat bread, and they were also obliged to drink tea and coffee. They never took tea and coffee before the famine.

Bread, as I have said before, is a very dry food; we are always obliged to take some liquid with it. I have no doubt that dumb animals suffer dreadfully, simply because those who have the care of them do not understand about food. They ought to live out of doors, where they can eat fresh green grass, &c., which contains so much water; and as they are out in the fields at night as well as day, they drink the dew that falls on the grass, and when it rains they get a great deal of moisture in that way. Animals that live on green vegetables may not require as much liquid as those animals do which live on dry foods, such as barley and oats. It is, however, wrong to suppose that they do not require any water. Sheep, cows, and other animals are often taken long journeys by land and water, and are driven along dusty roads, without having any water given to them. Two persons I know have seen sheep trying to drink the most filthy water as they were driven along. The cattle-drivers only laugh when you say they are thirsty.

A gentleman who went to buy a young rabbit from a rabbit dealer, a few weeks since, told me that he found the man out. His wife showed him a fine rabbit which had a large brood of young ones; the rabbit was feeding them entirely with her own milk. The poor animal was eating some kind of dry food—barley, I think. She was not allowed any water. My friend begged hard that the woman would give it something to drink. 'I dare not, sir; my husband would be so angry; he says they must not have any water.' A gentleman once fed a rabbit entirely on barley. In three weeks it was dead. A great many animals, such as parrots, are treated very cruelly in some zoological gardens, because the keepers have these ignorant ideas.

No wonder there is so much diseased butcher's meat in the markets, when we know the cruelty that is practised towards animals, and it will ever be so until those who have the management of them are less ignorant. I am thankful to think we can eat animal and vegetable food, which will make us strong and healthy, without being obliged to eat much butcher's meat.

The late Sir William Fairbairn, of Manchester, paid a visit to several foreign countries on purpose to learn how the working-people in those countries were fed. He found that the strongest men were the Turkish rowers. They eat bread, fruit, very little meat, and drink no wine or spirits. It is not wholesome to eat a great deal of meat, and I will now explain to you why.

The stomach must be nearly filled, so that the bag is stretched out, or the food cannot be properly digested. On the other hand, if the stomach is quite full, the food has no room to be moved from side to side; therefore it will remain undigested, because it cannot be broken up into small pieces. Half a pound of butcher's meat is considered enough for a man at one meal. Even a pound would not fill his stomach; he can therefore easily eat more than is good for him. People feel a craving until the stomach is sufficiently filled. In some countries earth and clay are mixed with the food to give it greater bulk, so that it may satisfy the stomach. Horses fed with oats, or any kind of grain which takes up little room, have straw, shavings, sawdust, mixed up with it for the same reason. People who eat a great quantity of meat daily often suffer from most dreadful complaints—the stone, and gout. If they get a slight cut or wound it often will not heal quickly. The Americans in the United States, rich and poor, eat as much butcher's meat as they like. No English people suffer so much from stomach complaints, nor are more unhealthy. It is said that the working people in Ireland, who live chiefly on vegetables (the potato), are not afflicted with gout. The French rarely suffer from disorder of the stomach. They eat at least a third less meat than we do, twice as much bread, and a great quantity of vegetables and fruit. Our blood, to be healthy, must contain at least forty different substances. These forty different things can only get into the blood through the food we eat. The French understand what foods contain, and they are determined that they will cook their food in such a manner that all these substances shall be carefully preserved. All flavouring matters are spoiled by too much heat. Beef does not taste like mutton. Vegetable foods, also, have each their different flavour: an onion does not taste like an apple. This flavouring matter is much weakened by heat. Albumen I showed you was also spoiled by being put into boiling water. The French never boil any good wholesome food. The first lesson a young French girl learns is to cook gently. The food in France is cooked for a much longer time than ours; in fact, it is always thoroughly tender and digestible. We are in such a hurry and fuss; and think that if the saucepan is only put on a good fire, and the contents boil, all is right. I will try and show you, during my lectures on cookery, that boiling is a most extravagant process, that we waste coal, burn our saucepans and faces, and injure our tempers, all for very little purpose, because the food upon which we have spent our time is spoilt. We are said to be among the worst of cooks. More butcher's meat is eaten in England than in any other country. The French are the best cooks in the world. Though they are less wealthy than we are, their poor people are better nourished than ours. I am not a vegetarian, but I believe in living as the French do, on a great variety of the most nourishing, simple, and well-cooked foods, and that butcher's meat is not the only food by which we can make flesh and strengthen our nerves and muscles. Fortunately, the most nourishing foods are the cheapest, as I intend to show in the next lecture.

*Things provided for the Lecture.*

Three bottles containing the quantities of water taken respectively from a pound of potatoes, a pound of rice, and a pound of wheat.
One pound of potatoes.
" " " rice.
A softened blade-bone from the School of Medicine.

A bottle containing phosphate of lime.
" " " . sodium.
" " " iron-water, to show how minerals may be dissolved and not seen by the naked eye.
Some blue litmus-paper.

*Experiment.*—Made some soda and proved it was an alkali.

### *Questions for the Sixteenth Lecture.*

1. If a human being or a dumb animal weighs 154 lbs., 111 lbs. of that weight will be water. How does all that water enter the body?
2. Why is it cruel not to give water to sheep, rabbits, and all other animals on long journeys, or when they are not finding their own food in fields?
3. Why is it good to eat fruit and uncooked vegetables, such as oranges, mustard and cress, and all kinds of salad?

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## LECTURE XVII.

### *FOODS* (*continued*).

After all I have told you about foods, I hope you will clearly understand that it is impossible for us to be healthy and strong unless we eat every day three entirely different kinds of food—nitrogenous, carbonaceous, and mineral foods. We will now read over some parts of the food table that I did not read over last time. I then only pointed out to you that there is, of course, much more water in wet foods, such as green vegetables and fruits, than there is in dry foods, such as grain—wheat and barley.

We will now compare the principal vegetable flesh-formers with the principal animal flesh-formers, to see if we could live on *animal* and *vegetable* nitrogenous foods, that would make our nerves and muscles strong, without eating much butcher's meat, as butcher's meat is very dear.

*Nitrogenous Foods called Flesh-formers.*

| Animal. | Vegetable. |
|---|---|
| Meat. | Flour. |
| Fish. | Oatmeal. |
| Poultry. | Rice (very weak). |
| Game. | Peas. |
| Eggs. | Barley, &c. |
| Cheese. | Revalenta Arabica (ground lentils). |
| | Macaroni. |
| | Semolina. |

The two principal vegetable flesh-formers eaten in England and Scotland are bread and oatmeal.

| Time to Digest. Hours. | |
|---|---|
| 3½ | 2 lbs. of bread cost *5d.*, and contain 3 oz. flesh-former, 20½ oz. body-warmer, ⅓ oz. ashes, 8 oz. water. |
| 3½ | 2 lbs. of oatmeal cost *6d.*, and contain 4 oz. flesh-former, 24 oz. body-warmer, ½ oz. ashes, 3 oz. water (uncooked). |

The principal animal flesh-formers are beef, mutton, and rich cheese.

| Time to Digest. Hours. | |
|---|---|
| 3½ | 2 lbs. of beef or mutton cost 1*s.* 10*d.*, and contain 7 oz. flesh-former, 4½ oz. body-warmer, ¼ oz. ashes, 20 oz. water. |

Component parts of rich Cheddar cheese in 2 lbs.:—Flesh-former, 9½ oz.; fat, 9¾ oz.; ashes, 1½ oz.; water, ½ oz.

Flour, oatmeal, ground rice, ground peas—1 lb. of any one of these vegetable flesh-formers will give a man as much strength as 3 lbs. of lean beef, or 3 lbs. of veal, or 3 lbs. of ham, boiled, or nine bottles of Bass's pale ale, or six bottles of Guinness's stout, 10*d.* per bottle. There is also as much nourishment in 1 lb. of double Gloucester cheese as there is in the above quantities of animal food and drink.

We will now see whether there are not a great many animal carbonaceous foods, besides the fat that comes from butcher's meat, which are very nourishing. There are also many vegetable carbonaceous foods.

*Carbonaceous Foods. Body-warmers.*

| Animal. | Vegetable. |
|---|---|
| Butter. | Sugar. |
| Dripping. | Treacle. |
| Suet. | Starch, which is in bread and all vegetables. |
| Oil. | |
| Lard. | |
| Fat. | |

A full-grown man requires daily 10 oz. of body-warmers and 5 oz. of flesh-formers. Water and ashes are not included in these quantities. These 15 oz. of solid food can be got either from animal or vegetable food. But some vegetables contain a smaller proportion of solid matter, because they have so much more water; we must therefore eat more of them. They take a longer time to digest than meat.

You see that a working-man, it is said, ought to eat 10 oz. of carbonaceous food daily, and only 5 oz. of flesh-formers. It is also said that 7 oz. of that food will be burnt in his body in 24 hours. That means that the carbon in these foods will join chemically with the oxygen in his body, and make the heat, strength, or force (for they are the same thing) he wants. Scientific men can tell how much fat will be burnt in a man's body when he lifts a heavy weight from the ground. The harder a man works, and the hotter he grows, the more fat he burns. He will not burn all the ten ounces of carbonaceous foods he eats in the day. Three ounces of the fat must be kept to lie between his muscles and cover his bones.

Animal carbonaceous foods, such as suet, butter, and all animal fats, are stronger body-warmers than vegetable fats or oils, because they contain more carbon. These animal fats are therefore the best kind for a working-man to eat who works out in the fresh air, where he will get plenty of oxygen gas. People who take very little exercise should be careful not to eat much carbonaceous food, or they will become fat. There was a French baker who grew to be so enormously fat that he did not like to go out of doors, because people stared at him, and rude little children in the streets made fun of him. He could not even raise his arm to put on his hat or stoop to draw on his boots. He thought perhaps he should grow thinner if he lived on slops, such as gruel, &c. But, alas! this food only made him grow fatter and weaker. Fortunately he met some one who understood the nature of foods, and who persuaded him to take nitrogenous foods, that make muscle, not fat, such as butcher's meat, cheese, eggs, &c., and also to take plenty of exercise. By following this sensible advice he soon became of moderate size.

It is very unwise of people to persevere in eating anything that they do not like or that does not agree with them, and it is cruel as well as unwise to force a child to take food that it does not fancy. Some people cannot eat hard-boiled eggs; others do not like them when they are boiled soft, and some cannot eat them at all. To some people shell-fish are occasionally very indigestible. I know a lady whose face becomes covered with large red spots if she eats oysters or any kind of shell-fish. I have heard of a man who was very fond of crabs, though they disagreed with him dreadfully. He determined he would try and make them agree, so he ate one every day for a week. Each day he became worse; at last he was so very ill that his family were obliged to send for a doctor. The medical man directly enquired about the food he had been eating. The reply was, 'Nothing but crabs.' 'Do they generally agree with you?' 'Oh, no; that is why I eat them. I was determined that my stomach should not master me.' The medical man assured him that it was only wonderful that he was alive, and that the crabs had not killed him.

Some men and women are so fortunate as to be able to eat and enjoy all kinds of food. A gentleman in Leeds told me the other day he had often eaten three-quarters of a pound of rich Cheddar cheese at a meal, and only felt stronger and better for it. Cheese is cheaper and contains less water and more nutrient solids than butcher's meat.

Healthy working-men who labour hard in fresh air can eat anything that is wholesome and well cooked. If we want good digestions, we must work hard too and earn our bread. Idle people who use neither body nor mind suffer a great deal from indigestion. As a rule they eat too much, because they have nothing else to think about but what they shall have for their dinners.

As I have said before, we should all try and eat every day a variety of food. The English people are so ignorant about the nature of foods that they are afraid of eating anything but just what they are accustomed to eat, and they often cook these few things very badly. If English people instead of French had been shut up in Paris for six months during the Prussian war, thousands of English would have died from starvation, because they would not have known how to make the best use of the little food they possessed. The French people are accustomed to eat nearly every herb and vegetable that grows which is palatable and not poisonous. By their freedom from prejudice, their knowledge of foods and cookery, they were able during the siege of Paris to make the best use of every bit of animal and vegetable food they could get hold of.

In France, Germany, and Russia both rich and poor take soup every day. It is the cheapest and most nourishing hot dish a poor woman can make for her family.

When I was in Russia, eleven years ago, I called to see a very poor widow with a large family who lived in Riga. Though it was winter time her little room looked very comfortable and clean. Her children were sitting round a table enjoying hot soup, which looked very good.

We were in Germany the year before last, and stayed at a beautiful town called Baden-Baden. I fortunately met a German lady there who knew a great deal about the poor and how they lived, because she used to go among them with money and other charities sent through her by the Princess Hohenlohe, who was a half sister to our Queen Victoria. This good princess was very much beloved. Miss ——, the German lady, took me to an infant school established by the Princess Hohenlohe. I also visited a school where poor children had a dinner every day, as well as their schooling. This dinner consisted of soup and a small loaf, or cake, of beautiful bread. I had some of this soup, which I found so good that I asked the matron if she would kindly tell me how it was made. 'We getup early,' she said—'at four o'clock—and cut some beef up into small pieces, put it into the oven, and stew it gently for four hours. Then we add milk, flour, and vegetables, which we stew very gently together, and the children have the soup about twelve o'clock with the loaf of bread.'

This soup, you see, contained the three kinds of food which make all the forty things our blood requires. The bread that the children put into the soup would make it nourishing and digestible, so that the organs would by this means have both liquid and solid food to work upon. The soup was also hot food. Hot food is much more digestible than cold food for people of all ages, but it is particularly necessary for the young and old. Their circulation is not very strong. Hot food enters the blood more quickly, and makes the heart beat faster, so that the blood circulates more rapidly. Directly an organ works hard more blood is required to repair that organ, for you know they are constantly wearing out. If you have eaten a good dinner you feel sleepy ; the blood leaves the brain and flies to the stomach, where it is wanted. Invalids who cannot sleep ought to have food in the night; then the blood leaves the brain to help the stomach, and the patient falls asleep. It is a bad habit to work either with the head or the hands directly after a heavy meal.

During my next four lectures I intend to teach you the principles of cooking. Before we begin to cook I think we ought to know all about the good things contained in the food we are going to cook. As I intend to show you how to make very strong beef-tea, I will read over to you the names of the juices and the different solid substances that beef contains.

*Table of the Substances contained in the Juices of Flesh.*

| | |
|---|---|
| Albumen. | Common salt and other salts. |
| Caseine. | Red colouring matter. |
| Sarcine. | More potash than soda. |
| Lactic Acid. | Osmazome, flavouring matter. |
| Butyric Acid. | |

You see albumen is put first, as it is one of the most important substances. If albumen, as I told you before, is cooked in boiling water (212°) it is so far affected that it becomes hard, and is then much less easily digestible. The savoury essences will also be separated by that heat and pass away in the steam.

We will suppose that there is a person very ill, whose nerves are very weak, and we want to make some strong beef-tea as quickly as possible, that will very soon be digested and made into blood, so as to nourish the weak nerves. What we must do is to try and get out all the good things that are in this piece of beef. Beef is the most nourishing animal food. Raw meat always feels wet; it is because the juices run out. Remember that the juices contain albumen, which is of a sticky nature. If I were to put this piece of meat just as it is into boiling water, the boiling water would harden the albumen that has run out with the juices and make it feel wet, just as if I were to take some glue and put it all over the meat. But I do not want to keep the juices in; I want to get them all out as quickly as possible. The cook will therefore cut the raw meat up into small pieces of about an inch in size, and put them into cold water. This meat weighs two ounces; I shall add exactly two ounces of water and a little salt. Take care and only put in a very small quantity, because salt hardens the flesh, just as boiling water would do. I will let the meat stand in the cold water for an hour or two if I have time; then I will put the jar which contains the meat into an oven moderately hot, and let it remain there for at least half-an-hour.

Here is some beef-tea that our cook made this morning; it contains the same quantity of meat and water that we have just used. It stood for half-an-hour in cold water, and then it was stewed gently in the oven for the same time. Just see how good it looks. Here is some beef-tea in another jar that was made at the same time with the same quantity of meat and water. The only difference is that it was put into boiling water and boiled for half-an-hour. You see how poor this beef-tea looks, and what a small quantity there is of it. The steam which is made when water boils carries off a great many good things and wastes the beef-tea. This beef-tea would not strengthen the poor invalid nearly as well as that which has been properly made.

*Things provided for the Lecture.*

Food table.

Names of the substances contained in the juices of meat.

Two glass jars of beef-tea, made from 2 oz. of beef and 2 oz. of water, according to the receipts given in the lecture.

*Questions for the Seventeenth Lecture.*

1. Name the three kinds of food we must eat daily that will keep us warm, make our forty organs grow and be strong, and keep our blood and skin healthy.
2. What dish containing these three kinds of food do the French, Germans, and Russians, rich people and poor people, give their children every day? How would you make this dish of food?
3. Why is hot food more digestible than cold food, particularly for children and old people?
4. How would you get all the juices out of meat, and how would you make the strongest and most digestible beef-tea?

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## LECTURE XVIII.

### *COOKING (BOILING).*

Last Wednesday I told you how you must cook any kind of animal food so that you might get all the juices out of it without hardening the albumen. To-day I am going to show you how you must cook animal and vegetable foods so that all their juices may be kept in. At the last lecture I read over the names of the different substances that there are in the juices of animal foods.

Vegetable foods, you know, contain substances which are very much like those of animal foods, only they have more minerals and salts.

All animals, except man, eat their food raw (uncooked). They eat the same things as we do. Why, then, do we take the trouble to cook our food? Because we find from experience that some foods have a much better flavour when they are cooked. For instance, if you tried to eat a piece of raw beef, you would find it had a very different flavour from that of the roast beef you eat on Christmas Day. A raw potato does not taste at all like a boiled one.

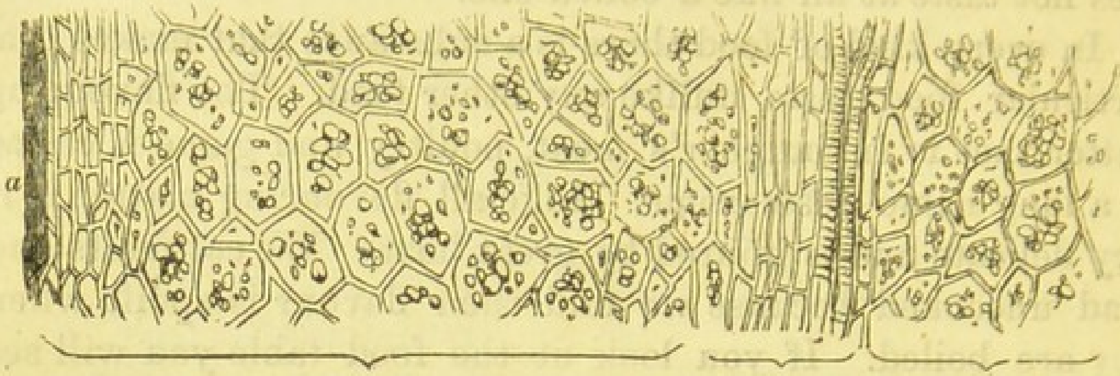
In every kind of food there is a substance that makes that particular food taste unlike any other food. The flavouring matter that is in butcher's meat, poultry, and game is called by a long name—osmazome. Like all flavouring matter it is very delicate and is injured by great heat. We eat fruits and salad uncooked because we find their flavour is spoilt when they are boiled. If you look at the food table you will see that some vegetables take a longer time to digest than animal food. I believe they would digest much more quickly if we understood how to cook them properly.

| Hours to Digest | One Pound of | Hours to Digest | One Pound of |
|---|---|---|---|
| 3 | Meat. | $3\frac{1}{2}$ | Bread. |
| $3\frac{1}{2}$ | Cheese. | $3\frac{1}{2}$ | Potatoes boiled. |
| 2 | Milk. | 2 | Potatoes roasted. |
| 3 | Eggs. | $4\frac{1}{2}$ | Cabbage. |
| 4 | Veal. | $2\frac{1}{2}$ | Kidney or Haricot Beans. |
| 4 | Fowls. | | |
| 4 | Pork. | | |
| 1 | Tripe. | | |

You see that a roasted potato only takes two hours to digest, a boiled potato three hours and a half. One reason, I think, is because the roasted potato has lost none of its salts, as it does when it is boiled. The salts and juices all help digestion.

Here is the picture of a slice of a potato. You see that the starch grains are held between cells or spaces, which look like a network. The substance that makes that network is chiefly cellulose gluten. In young potatoes, and particularly in all young fruit and vegetables, there is a great deal more of this network, which is called cellular tissue. Animal foods contain a cellular tissue, which forms a sort of framework in the organ, but it is not like the vegetable tissue, as it gives gluten when it is boiled. One reason why we cook food is to make the tissues tender. We cannot do so if we harden the albumen of which they are principally made. I think

FIG. 33.




Highly magnified slice of a young potato. *a* is the rind, and is like cork on the outside skin; the inner skin is albuminous and makes flesh. The grains in the many-sided spaces or cells are starch grains; the network that holds them is called cellular tissue.

you must be curious to know with what degree of heat you are to cook, as I have told you never to cook meat or vegetables in boiling water.

You see I have written down this information, and you must copy it carefully, as it is very important you should be able to remember it when you have to cook for yourselves. Every kind of animal and vegetable nitrogenous food will be thoroughly well cooked if allowed to remain long enough in water that is at 180°. The albumen becomes solid at that heat, but it will become hard and less easily digestible, like the albumen in a hard-boiled egg, if it is cooked in boiling water, which requires a temperature of 212°.

I am now going to show you how to boil a potato. Remember, if you know how to cook a potato, you will know how to boil any fresh green vegetable. First of all, the potato must be nicely washed in cold water, as this has been. Next you must take out all the earth that rests in the little holes. Some people use a knife to do this, but a knife may cut the skin. A brush, such as our cook has in her hand, is much better. You must not let any vegetables stop more than a few minutes in cold water (of course you would never wash any vegetable in warm water), or it will make the skin soft and the juices will come out. The skin of a potato is made of a corky substance. You know people put corks into bottles to prevent the liquids from running out. Well, this outside skin of the potato, being of a corky nature, will prevent the juices from running out. That is why the skin of a potato ought never to be taken off before it is cooked. The Irish, who nearly live on potatoes, do not take off the skins. If you look at the picture of the slice of potato, you will see this corky skin. The next skin contains a little albumen. Now I will put this potato into boiling water and let it remain there for a few minutes, just to allow the boiling water to harden the albumen in the second skin. Its salts and juices will then all be fastened up, and the boiling water will not have had time to go far into the potato to harden the tissues and juices. It has now remained a few minutes (which is quite long enough) on the fire. I will take the saucepan off and place it on this hob, as the heat of this hob is great enough to keep the water at 180°. Here it must remain for three-quarters of an hour. It is not necessary to keep watching how hot the water is, for you will soon learn from experience that a hot hob near a warm fire or a moderate oven will keep the water at the right heat. A saucepan ought never to be left at the edge of the fire, for then the sides would get burnt and the food also. You see that the saucepan has its cover on; this is a *most important* part of cooking. The cover should be instantly put on when the food is put in. No food should be put into a saucepan that has no lid, because the steam will then take away the heat and the flavours.

Vegetables cooked in the proper way require a longer time, it is true, but surely it is worth while to give them more time, if by so doing they are made more nourishing and digestible. Less fire will also do when the pot need not be kept 'a-boiling'—a most favourite English expression. Our kitchen grates are old-fashioned ones. When our cook thought she ought to let the saucepans boil she often found it was necessary to have two fires. Now she finds one enough even when she has a large dinner to prepare, and she tells me she never feels in a hurry, as she used to do, nor afraid lest the food should be burnt or underdone.

I am very anxious that you should understand that it is very bad—indeed, dangerous to some people—to eat the skin of a roasted potato. Now that you know the skin is like cork, you will understand why it is unwholesome.

We will now boil an egg, so that the albumen shall become solid, but not hard, and the yolk shall be soft. I will put this egg into boiling water, but I will not let the saucepan remain an instant on the fire. I only wish it to be put into boiling water. The cover, you see, is on. I will now put it on this hob, which is warm, and there I will let it remain five minutes; a minute or two longer will not make it hard. It is very important to keep on the lid; indeed, an egg could not be cooked in this way unless the saucepan was covered, because it is cooked a great deal by the steam.

I will now poach an egg. The egg which is taken out of its shell will be put into this boiling water. It is really boiling water, as you see by this thermometer. You will find from experience that water does not always boil directly it begins to bubble. The safe plan, therefore, is to let it boil for some minutes before you put anything into it. Directly I put the egg into the boiling water, I put the cover on, and instantly remove the saucepan from the fire. It shall remain on the hob about the same time that I let the other egg remain—from five to ten minutes, just as it suits me. No doubt it would be quite done in five minutes, but it would not be spoilt if left a little longer. By cooking an egg in this way we do not require a clock or a thermometer, and if it is a good fresh egg it will be beautifully cooked. I have found that stale or bad eggs can never be cooked well by any heat, however much trouble you may take with them. Of course it will be the same with all stale or bad meat and vegetables. An egg is animal food; if you know how to cook it well, you will know that the same heat will cook any kind of animal food. Here is a hard-boiled egg; it has been boiled in boiling water for ten minutes. Let us compare it with the poached and soft-boiled egg. The albumen, or white part, in both of them is creamy, and the yolks are soft. Though I did put these two eggs into boiling water they never boiled, because the eggs, being cold, cooled the boiling water, the temperature of which went down quickly from 212° to 180°. The first time I cooked an egg in this way I put the egg into water at 180° instead of putting it into boiling water. The consequence was that the egg was not done enough, for the cold egg had made the water much colder than 180°. Hard-boiled eggs are excellent things to take on a long journey, when you cannot get any animal food, as they take a long time to digest, and so prevent your feeling hungry. Sandwiches made of bread and butter, with hard-boiled eggs chopped up finely and put between the bread, are excellent. The yolk of an egg contains a great deal of carbonaceous food. In Russia they take the oil out of the yolks of eggs and sell it as a medicine. There are two drachms of oil in each yolk of a hen's egg.

I will now show you a very wonderful box called a Norwegian self-acting cooking apparatus. If you look into it you will see that it is lined with a kind of cloth called felt. Felt is a material made of hair and wool that allows scarcely any heat to pass through it. There is a saucepan in the centre. This saucepan has four divisions. Come and touch the pan and you will find that it is very hot. You must look and see what there is in these four places. The first contains a rolled jam pudding; the second a rice pudding; the third an egg. In the fourth there is a stew. This stew contains a piece of beef beautifully done, also a suet dumpling, carrots, turnips, celery, onions, and potato. Not only is the stew well cooked, but it tastes excellent. There has been no steam to carry off the flavouring matter. The pans are quite full, so that there has been no waste. Our cook had very little trouble. She merely prepared these three dishes and put the pan into the oven until the puddings and stew began to boil, then she instantly put the pan into the box, which was aired by the fire, placed this felt cover over the lid, shut it up, and put it in a place free from draught for seven hours. The working people in Norway use them constantly. I wish I could tell colliers, mill hands, working men and women, about this wonderful box. The Prince of Wales has taken one out to India. I am glad that this apparatus proves I am right in saying that foods are injured and wasted by being boiled at 212° for more than a few minutes after they have been placed in the saucepan. Full directions will be found in the Appendix (p. 195). The Norwegian Cooking Apparatus can be bought in all sizes from 12*s.* to 3*l.*, at Silver's, 66 Cornhill, London. The box you have seen to-day is a travelling one, marked B. As I wished to show you several dishes at one time, I had the saucepan fitted up with four small pans, which have answered very nicely. When not used the box and saucepans had better be left open. This rule ought to be carried out with *every* cooking utensil.

*Things provided for the Lecture.*

A bottle with a cork in it.
A picture of the slice of a potato.
Three eggs.
A Bunsen burner.
A thermometer.
Two small saucepans.
An old and a new potato.
A brush to clean potatoes with.
A slice of a potato cut like the picture.

*Questions for the Eighteenth Lecture.*

1. Why do we cook our food?
2. How would you boil a potato, or any fresh vegetable?
3. Why is a roasted potato more easily digested than a potato cooked in any other way? (It is digested in one hour less time.)
4. Why must a cover always be put on a saucepan all the time the food is being cooked, unless the pan is a copper one not tinned inside?
5. How would you cook a fresh soft-boiled egg, or a poached one, if you had neither a clock nor a thermometer—in fact, had to do it by guess?

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## LECTURE XIX.

### *COOKING (continued).*

We intend, if there is time to-day, to cook the following things: —A mutton chop, so that all the juices shall be kept in, and the meat be tender and tempting for a delicate stomach; some rice and macaroni, so that it can be eaten with any kind of meat, or with milk and sugar, or with treacle alone.

Before the cooking begins I must ask you to examine the fireplace we have brought to cook with. Mr. Wilson, the tinner in Woodhouse Lane, has taken great pains to make it exactly like the fireplace that every English working-man has in his own home. It has not got an oven, only a place where an oven ought to be, as it was necessary to make the whole thing as small and light as possible. I am obliged to burn charcoal, as coal would make a great deal of smoke, and we have no chimney to carry it away. We will now put a plate to warm before the fire, so that it may be ready for the chop when it is cooked. We shall only use the same saucepans and cooking utensils that you are accustomed to see used.

Here is the gridiron; you see it is very clean. If it were not very clean, the flavour of the mutton chop would be quite spoilt. As the fire has now burnt up bright and clear, we will put the gridiron over it for a few minutes to get the bars hot, for then the chop will not stick to the bars; some people rub grease on the bars, but that is not a good way. The chop must not be put on with a fork, as the fork would make holes in the meat and let out the juices. By means of a spoon and a knife it is easily put on. As we want to keep all the juices in, we will put the gridiron very near the hot coals, and then the red heat will directly harden the albumen that is on the outside of the chop, and so fasten in all the juices.

A fine chop will take twelve minutes to cook thoroughly; a very thin one, a minute or two less. Remember, it must be turned six times—that is, once in every two minutes. No person ought to cook a chop without a clock or a watch to look at, as great care is required to cook it well. Directly the chop is ready, it must be put upon a nice hot plate; if the plate is cold, the chop will be spoilt, however well it has been cooked. The next thing is to eat it directly; a chop should be carried from the fire to the dinner table. Do not put butter or anything on the chop. It is best eaten with a little salt and a good potato. A person with a very delicate digestion could eat a chop cooked in this way when he could eat nothing else. Now I will cut this chop open, to show you how nicely it is done. The flesh is not at all red, only full of juice. A beef steak ought to be cooked in exactly the same way.

I will now show you how to roast a joint of meat. You must have the same clear, bright, red fire to roast by which you require to cook a mutton chop with. We will suppose that this is a loin of mutton; it is really only two chops cut from a loin of mutton. As we want to keep all the juices in this joint, we must let it hang as close to the fire as possible for ten minutes. Then the great heat that comes from a clear hot fire will in that time harden all the outside of the meat, and so fasten up the juices. When this is done, we must move the meat to a great distance, and let it cook very gently. The fire must never be allowed to burn low; it must continue clear and hot until the meat is done. The meat must also be constantly basted; that is, the melted fat that falls into the dripping-pan must constantly be poured over it with a spoon, because the fat keeps in the juices and prevents the meat from burning and being cooked too quickly. Take care to keep the dripping-pan a good distance from the fire, so that no pieces of coal can fall into the dripping and make it dirty. No fat ought to be more highly prized than dripping, for it is almost the most nutritious fat that can be eaten. Dripping is much nicer than lard for frying fish, &c.; it also makes excellent short crust for fruit pies. If any coal should fall into the dripping-pan, the dripping, when cold, must be put into boiling water. When it is melted, the bits of cinder and dust will fall to the bottom, and the dripping will rise to the top in a large white cake. It is not at all an easy thing to roast a joint of meat properly, for it takes one person's time nearly to look after it and to keep the fire bright.

A mother who has a large family and a baby to look after cannot be expected to roast meat very often. A friend of mine told me that her mother, who was a working-woman, never could give them roast meat when they were children, unless it was on a feast day, when one of her elder children was at home (as it was a holiday), and could attend to the fire and baste the meat. The old-fashioned way of roasting meat was to place it at some distance from a black new-made fire; it was considered the best plan to let the meat and the fire grow warm together! As we have very little time left, I must take away the meat. I think you will have learnt from what you have seen how to roast a joint of meat before the fire.

We will now cook some rice and macaroni so that they may be eaten with any kind of meat, like a vegetable, or with milk and sugar, or with treacle alone. The rice has been well washed two or three times in cold water, but was not allowed to stand in it. Macaroni must never be washed. We shall cook them both exactly as we cooked a potato. As the water is now boiling in this saucepan, we will put the rice into it. As the saucepan is very small, we must put very little rice in, or the rice will not have enough room to swell out. There is a great deal of starch in rice and all vegetables, you know. Each starch grain swells very much.[1] Here is a picture of one before it is boiled, and here is the same grain when it has been cooked.[2] You see it has grown three times as big. Vegetables are very often spoilt by being put into too small a saucepan with too small a quantity of water. We will now put on the macaroni. Like rice, it also will require a very great deal of room. These three little pipes which I am going to put in will become very much larger when they are cooked. As the rice and macaroni have now boiled for a few minutes, we will put a saucepan on each hob and let them cook gradually. While they are cooking I will tell you a little about rice and macaroni, and the countries they come from. In China and India the natives live chiefly on rice. The Hindoos are now suffering from a famine because the rice crops failed last year. Though rice is a very good food, it is a dreadful thing that the Hindoos will eat hardly anything else—first, because their bodies and minds would be stronger if they ate different kinds of food, and another reason is that it is a fearful thing for any people to depend on one food, for when that food fails there must be a famine. People died by thousands and thousands in India during a famine of this kind some years ago, and as many more had fevers and all kinds of complaints owing to their not having had half enough to eat.

In Ireland, you know, there was a famine several years ago, too, because the Irish people lived mainly on one thing—potatoes. I fear they still eat very little else in many parts of Ireland.

The working people in the south of Italy live almost entirely on macaroni. Macaroni is a most nutritious food, because it is made chiefly of vegetable albumen—that is, gluten, that substance which makes our flesh, nerves, and muscles, and is called nitrogenous food. I am sure your mothers would

[1] I showed a drawing of two starch grains, p. 89.

[2] Page 89.

often give you both rice and macaroni if they knew how easily these foods are cooked. Rice, you know, is very cheap. The rice we are cooking to-day only costs threepence a pound; two ounces would make a good-sized pudding. Two ounces of macaroni would also make a large dish; therefore it is a very cheap food, although it costs eightpence a pound, because it is very nutritious and swells out so much when cooked. The straight sticks are better than the twisted. The sticks must be broken into small pieces about four inches long, or to suit the saucepan. The macaroni you see in this dish [1] was first boiled in water, like a potato or any green vegetable; it was then placed in the dish; a little pepper and salt were added, some cheese was grated over the top, and it was put into a hot oven until it was nicely browned. Here is a rice pudding that is made of skimmed milk, with a little suet chopped up very fine in it. You see how good it looks, quite rich. The goodness of all puddings, particularly those made of rice or tapioca, depends on their being cooked very slowly and on their having *plenty* of room to swell out. Dripping does as well as suet in case the milk is poor.

Semolina costs eightpence a pound. It is made chiefly of gluten, and is therefore a most nourishing food. Semolina is eaten in *great quantities* by the Italians; they call it polenta. In Algeria it is the national dish called couscousou. Fermenty is a dish eaten in Yorkshire at Christmas time. It is made of wheat and water, which are cooked in the oven until the wheat is tender, and then currants and milk are added. This is a most nourishing food, and not indigestible if the wheat is crushed. The Americans call it mush. The Syrians live almost entirely upon it. It is their daily national food.

Revalenta Arabica is only ground lentils. Lentils are stronger food than grain; they are much given to cattle, but they are also very good when put into soup. There is a food called corn-flour which, I am sorry to say, is given in great quantities to infants. Corn-flour, like arrowroot, is almost entirely made of starch, which you know produces fat in the body. The babies fed on corn-flour grow fat, and because they grow fat the nurse or mother concludes that the child is doing

[1] I showed a small dish of cooked macaroni.

splendidly, when all the time the poor little thing is being 'pined' to death, because it has no food to feed its muscles, nerves, and bones.

*Things provided for the Lecture.*

A picture of a starch grain, cooked and uncooked.
A gridiron.
Two saucepans.
One knife.
,, metal spoon.
,, ounce of rice to boil.
,, ,, ,, show how much it had swelled when boiled.
One ounce of macaroni to boil.
,, ,, macaroni cold.
One chop to grill.
Two chops to represent a joint.
A dinner plate.
A small rice pudding.
A small dish of macaroni prepared with cheese grated over the top.
A small model kitchen range.

*Questions for the Nineteenth Lecture.*

1. How would you cook a mutton chop or a beef steak, so that all the juices should be kept in, and the meat be tender and tempting for a delicate stomach?
2. How ought a joint of meat to be roasted before a fire?
3. Why will all vegetable food, such as rice, flour, potatoes, and all green vegetables, be made sad or heavy if they do not have plenty of room to swell out in the saucepan while they are being cooked?
4. How would you cook rice so that it could be eaten with any kind of meat, or with milk and sugar, or with treacle alone?
5. How would you cook macaroni so that you could eat it with any kind of meat, cheese, or with milk and sugar, or with treacle?

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## LECTURE XX.

### *COOKING (continued.)*

The French are not only excellent cooks, but they are most economical with their food. They waste nothing. For instance, if they boil any kind of food, no matter whether it is fish, flesh, fowl, or vegetable, they always take care of the water in which these foods have been cooked, and make soup of it, except that water in which potatoes have been boiled with their skins on. The French people evidently know what you know now—that every kind of food contains a great many good things, and that some of those good things must come out into the water, however carefully the food may have been cooked.

Soups made from the liquid in which fish has been boiled are very good, unless the fish has been salted. In the same way, you cannot make soup of the water in which salt meat has been cooked. For this reason salt meat is an extravagant food, because the water in which it is cooked is useless. Another reason why salt meat is extravagant is, that when salt is put on any meat the salt draws out its juices. The brine that comes from salted meat is the part that contains most of the juices, and that part is thrown away. This is done in England even with the water in which fresh meat has been boiled. It is only a very few years ago that several of our soldiers who lived in some London barracks were nearly starved to death. They became very thin and weak. It was considered very strange, as the best fresh meat was bought for them, and they had some of it every day. At last an enquiry was made. It was then found that they never had anything but boiled meat, which was boiled to a rag, and the cook always threw away the liquid in which it was boiled. This story proves very clearly that even English cooks do not understand anything about the different properties of foods and the principles of heat by which they should be cooked. No person ought to call himself a cook who does not know these things.

I will now tell you how to make clear stock for soup from butcher's meat. Here is some meat stock in this glass jar. You see it is quite clear. The reasons why this stock is so clear are, first, because the meat and the bones with which it was made were put into a *perfectly* clean saucepan, with cold water, of course, as the juices had to be brought out of the meat. Secondly, because the meat was never allowed to boil, only to simmer. If soup boils the albumen in the meat becomes hardened and rises in little bits to the top and makes what is called 'scum.' Even if the soup does not boil a scum will rise if the saucepan is not spotlessly clean, for any old bits of food that were sticking to the sides and bottom of the pan will come off and rise to the top; then the soup will taste disagreeable and it will be thick. English professed cooks will tell you that soup cannot be clear unless it *boils* for a quarter of an hour, and that during this quarter of an hour you should throw in a little cold water to make the 'scum' rise, and keep taking it off with a spoon. All the time the scum is being removed the cover is kept off, and the steam is carrying off the flavouring matter, injuring the juices, hardening the albumen, and wasting the soup. The stock in this bottle was allowed to boil, and the scum was removed; but it is not clearer than the stock in this other bottle, which never boiled and had no scum removed. There is, you see, a great deal more of the soup that only simmered than of the boiled soup, to say nothing of its being more nourishing.

The most nourishing beef-tea for invalids is often prepared by putting the beef into a jar which is placed in a pan of boiling water. Custards, milk, and other foods are often prepared in the same way. No food can be brought up to boiling point in a pan which is merely surrounded by boiling water. This is a scientific fact that all ought to know. Captain Warren's famous cooking pot is constructed on this principle—the steam that is made by the boiling water in the outer pan passes into the lid, which is double, or into a steamer which, if wanted for vegetables or puddings, can be put over the cooking pan. It is quite impossible that any steam can enter the middle pan: here the food is cooked by hot air so that it loses none of its flavouring matter, and scarcely any of its weight. When soup is wanted, water, of course, is used. We have cooked several kinds of food with the greatest success in Captain Warren's 'Everybody's Cooking Pot.' A few days since an article appeared in the *Times* describing this apparatus, from which I give the following extract:—'The heat to which the food is subjected cannot be greater than 210 deg. Fahrenheit; and the closure of the vessel, and the consequent gentle stewing of the meat or fish in its own juices, is attended by a very remarkable prevention of waste and preservation of flavour. It is estimated that the loss of meat by ordinary methods of cooking is about one-third by roasting, or $5\frac{1}{3}$ oz. in the pound, about $4\frac{1}{4}$ oz. in the pound by boiling, and about $3\frac{1}{2}$ oz. by baking; while the loss by Captain Warren's process is altogether insignificant. Thus, Captain Harrison, R.N., records an experiment tried under his supervision on board the Shannon mail-boat, in which a leg of mutton weighing 12 lb. was cooked in the ship's oven, and when considered well done was found to weigh 8 lb. On the following day the other leg of the same sheep was cooked in one of Warren's pots, was placed in the ship's oven for a few minutes to be browned, and when taken out was found to weigh 11¼ lb.'

My cook will now make a nourishing cheap soup that shall contain both animal and vegetable food without using any butcher's meat. Before she begins to make the soup, pray notice how clean the saucepan is. She will put in a pint of cold water. When it boils, the following vegetables will be added. All green vegetables should be put into boiling water, though they are not to be boiled, or else they will lose their colour. A little sugar also keeps them green. Soyer, the celebrated cook, never made a soup without putting in some sugar, as it is very nutritious. I will now tell you what the quantity of vegetables, &c., ought to be for this soup: two pints of water, two ounces of green peas (carrots or any vegetable will do), one onion, one lettuce. All the vegetables must be cut up very fine; if carrots are used, they should be scraped (carrot soup is the nicest of all vegetable soups). To this must be added two cold potatoes, or uncooked ones, one tablespoonful of flour or oatmeal mixed up with two ounces of dripping, half a teaspoonful of sugar, some salt and pepper, and half-a-pint of milk—the milk to be added when the vegetables are done. Milk is not necessary for the soup, only it makes it more nourishing. These must all simmer gently for nearly an hour, and then the soup will be quite ready to be eaten. Split or dried peas require a much longer time—about two hours—and this is the most nourishing soup of all.

Now we will just see how it is that this soup is made of animal and vegetable food, although it contains no butcher's meat. Well, the dripping is animal food, and so is the milk. What a good nourishing meal this would make if some bread were eaten with it on a cold winter's day. It is also so easily prepared. A mother might make it in the morning early, so that her husband or children could take it with them to the mill, where they could warm it up, or she could get it ready after breakfast and put it into a slow oven, so that if she was obliged to go out in the morning it would be ready for dinner when she returned. This is what the French women always do.

At the end of the lecture you shall taste some soup which was made this morning at home. It is made exactly like the one we have just prepared for cooking. An immense number of soups can be made without butcher's meat.

Remember the stomach must have a solid, or else the organs which digest solid food will get out of order, and the person will grow weak. Doctors say that many lives have been lost because nurses have given sick people nothing but beef-tea after they have become much reduced by a severe illness. The different essences of meat, like beef-tea, do not feed and strengthen, but only stop the waste of the nerves and muscles.

The following extract from Dr. Edward Smith's remarks made at a meeting of the British Association in 1872, will prove the truth of what I have just said:—'Then we shall no longer have sick and dying men, women, and children fed with Liebig's extracts of meat under the delusion that it is nutriment in the ordinary sense. Liebig's extract is meat flavour, a nervous stimulant, and has good qualities, but it is not food.'

Another extract from a publication called 'Land and Water' bears on this subject:—'How many a recovering patient has sunk under the stimulating beef-tea which suited his period of prostration, but which starved his returning strength. How many a weakening frame has been lost by the attractive but worthless jellies which pious and loving hands had carefully prepared.' The same authority says that butter and eggs should be added as soon as possible to the beef-tea, or to the food in some way. These two foods, butter and eggs, contain body-warmers, and will therefore make fat. Fat burns away in the body very quickly when anyone has a fever. It is an important fact that no one can live unless his body contains a certain quantity of fat.

Cold meat, you know from what I have told you in one of my lectures, is not so nourishing as hot meat; it is therefore very necessary that we should learn how to make a good hot dish with cold meat. Whether we hash or mince cold meat, we must take great care and make a good gravy to warm it up in, and cook the meat very little the second time. The gravy must also have a pleasant taste and a good flavour, because the meat will have lost a great deal of its flavouring matter, called osmazome, while it was being cooked the day before. This is why there is scarcely any flavour in cold meat. You know that hot meat and cold meat taste quite differently. It is a fact that a nice taste or a good smell makes our mouths water—that is, causes the saliva to flow. When the saliva flows into the mouth, the gastric juice also comes into the stomach. As the saliva and the gastric juice help our food to digest, it is very important that what we eat should taste, smell, and look good. A dirty tablecloth, dirty knives and forks, dirty plates, take away the appetite of even strong people; while poor invalids and delicate persons are often prevented from eating the food they so much need, and upon which their very lives may depend, because it does not look or smell tempting, and is brought to them in a dirty and untidy manner.

The following is a receipt for making gravy for a hash or a mince without meat stock:—

Put a teaspoonful of flour, a little dripping, and an onion into a saucepan; hold the saucepan over the fire until the onion is nicely browned; do not let the onion burn, or the flavour of the gravy will be quite spoilt; add half-a-pint of boiling water, pepper, salt, and a little nutmeg; instead of nutmeg any sauce can be used that is liked, such as ketchup. Let these things simmer a short time; then put in the cold meat, cut into small slices. Put on the cover, and let the hash simmer gently on the hob for ten or fifteen minutes, until the meat is quite hot.

When we *stew* we ought to use fresh uncooked meat; a stew is therefore very different from a hash. We stew meat in order to make the flesh or tissues tender. We also want to keep in all the juices; we must therefore take care and see that the water or gravy which the meat is put into is boiling. The meat must then be stewed for a long time in a moderately hot oven. Tough meat should always be stewed. The following is the most simple receipt I know for stewing a beef steak or any meat in a way that would suit an invalid with a delicate stomach :—

Take off all the fat and skin from a rump steak nearly an inch thick ; just dip it into boiling water, sprinkle a little pepper, and then flour it on both sides rather thickly. Wash out the stew-pot with boiling water : put in the meat with about a tablespoonful of water, and let it stew gently until it is tender. The salt brings out the juice ; therefore put it in at the last. A thick slice of mutton is very good stewed in this way.

As there is an immense quantity of tea drunk in England by both rich and poor, I am going to tell you the good and the harm it does to our health. Here is a list of the substances there are in tea.

In one pound of tea are to be found the following substances :—

| | OZ. | GRAINS. |
|---|---|---|
| Water . . . . . . . . . | 0 | 350 |
| Theine . . . . . . . . . | 0 | 210 |
| Caseine . . . . . . . . | 2 | 175 |
| Aromatic Oil . . . . . . . | 0 | 52 |
| Gum . . . . . . . . . | 2 | 385 |
| Sugar . . . . . . . . . | 0 | 211 |
| Fat . . . . . . . . . | 0 | 280 |
| Tannic Acid . . . . . . . . | 4 | 87 |
| Woody Fibre . . . . . . . | 3 | 87 |
| Mineral Matter . . . . . . . | 0 | 350 |

Theine is the nutritious substance. The volatile oil gives the flavour of tea. The latter, like all flavouring matter, is a most delicate substance, and would all fly away if the tea were boiled. This is the reason why we only pour boiling water on tea when we make it. Theine has a great effect upon the nerves ; for this reason, when tea is taken very strong, it often keeps people awake the whole night.

Tannic acid, which you see the tea contains, is the same stuff which tanners use to tan leather. This acid hardens albumen in the stomach; that is why it is not a good thing to take meat with tea. Theine stops the gastric juice from flowing freely into the stomach. Cold bread and butter are the most wholesome foods to take with tea.

I will now try and describe the effect a cup of tea has upon our bodies. We will suppose that a poor woman feels faint from want of food. She has nothing in her stomach, and takes a cup of tea. It is cold weather. For a short time the tea warms her, and she feels happier and more cheerful, for the theine in the tea has supported her nerves. It always does this if taken in moderation and not too strong. After a little time, the woman begins to feel colder and weaker than she was before she took the tea. There is scarcely any nourishment in tea except that which is got from the sugar and milk. Tea has a very powerful effect on the skin; it opens the pores and makes us perspire. The poor woman will therefore be thinner and weaker after her cup of tea, because the perspiration will have carried off some of the wasted or used-up substances of her body, and she had none to spare.

It has now become the fashion for ladies to take a cup of strong tea at four o'clock, after a good meat lunch, and before they take a good dinner at seven o'clock. Their cup of tea will no doubt do them good, because they will be all the better for the waste that the cup of tea will cause. I am very anxious to give this information about tea, because I am quite sure the mothers and daughters of the working-classes in England injure themselves very much by taking too much tea. Many wives and mothers used to come and talk to me at the end of the lectures I gave last winter, and I was very sorry to find from what they told me how much they suffered from bad health. Face-ache, tic, rheumatism, and bronchitis were very common complaints. I found that nearly all of them were in the habit of taking a great deal of tea. Mill-girls, who work in close rooms, become unhealthy, and then they easily take cold. Tea makes them more tender, because it opens the pores of their skins and makes them perspire, so that when they come out of the close warm rooms on a cold day, or at night, they easily take cold.

No persons except doctors work harder than the industrious wives of working-men, and they are your mothers. They not only work all day, but they are often obliged to work all night if they have a sick child. No women require more nourishing food. They ought to take very little tea, unless they can have the best food.

We will now learn all we can about coffee. This list will tell us what it contains.

In a pound of coffee there will be :—

| | OZ. | GRAINS. |
|---|---|---|
| Water . . . . . . . . . | 1 | 407 |
| Sugar . . . . . . . . . | 1 | 17 |
| Fat . . . . . . . . . | 1 | 402 |
| Caseine . . . . . . . . | 2 | 35 |
| Caffeine, or theine . . . . . | 0 | 122 |
| Aromatic Oil . . . . . . . | 0 | 1½ |
| Caffeic Acid (with Potash) . . . . | 0 | 280 |
| Gum . . . . . . . . . | 1 | 192 |
| Woody Fibre . . . . . . . | 5 | 262 |
| Saline Matter . . . . . . . | 1 | 31 |

You see there is no tannic acid in coffee; but there is a substance called caffeine, which is the same in nature with theine, having the same chemical composition. It also affects the nerves, and keeps people awake if they take it too strong, but will soothe and cheer them if they only take a moderate quantity. The peculiar taste of coffee is also due to a volatile oil. Like all flavouring matter, it is very delicate, and is spoilt by boiling. No one ever thinks of boiling coffee; it ought to be made exactly as tea is made, by pouring boiling water upon it. Coffee can be kept for a long time hot on a hob, where the heat will be about 180 degrees, and will not be spoilt. Cold coffee is very disagreeable. Coffee does not open the pores of the skin as tea does; on the contrary, it is said to shut them up, and therefore it does not waste the body, it only makes the blood hot.

In France and Germany very little tea is taken. Every poor person takes coffee for breakfast and tea. They make it a very nourishing drink, because they only half fill the cup with coffee; the other half is hot new milk or skimmed milk, and then they add a great deal of sugar. Coffee is said to prevent people from having gout and rheumatism. I know that when I nursed a friend who had a dreadful attack of gout, his pain was always relieved, when I gave him a hot cup of coffee and hot milk in the middle of the night. Remember the milk should always be made very hot that is taken with coffee. Milk should *never* be boiled, because the albumen gets hardened and rises to the top, and makes the skin you have often seen on the top of a cup of milk.

Now we are going to learn about cocoa and chocolate. Perhaps you do not know they are both made from exactly the same kernel of the tree called *Theobroma cacao*, which grows in America and the West Indies. Chocolate and cocoa are prepared in a great many ways. Cocoa or chocolate is very good for people who can eat fat food, such as children and young people, but it does not suit all bilious people.

One pound of cocoa or chocolate contains :—

| | OZ. | GRAINS. |
|---|---|---|
| Water | 0 | 350 |
| Albumen or Gluten | 3 | 85 |
| Theobromine | 1 | 140 |
| Cocoa Butter | 8 | 0 |
| Gum | 0 | 426 |
| Starch | 1 | 53 |
| Woody Fibre | 0 | 280 |
| Colouring Matter | 0 | 140 |
| Mineral Matter | 0 | 280 |

You see that there is a great deal of fat in it. Cocoa ought to be cooked gently and allowed to simmer for half-an-hour or more, and have a great deal of milk, which should simmer with it. It is a great pity mill-girls do not take it instead of tea. Cocoa-nibs ought to simmer for two or three hours; they cannot be done well in less time.

### *Things provided for the Lecture.*

A glass bottle of soup made of vegetables, like the soup we made at the lesson for the children to taste.

Two pints of water, two oz. green peas, a cold potato, one tablespoonful of flour, two oz. of dripping, half a teaspoonful of sugar, pepper, salt.

One gill of milk.

### *Questions for the Twentieth Lecture.*

1. How could you make a great many most nourishing soups, which should contain both animal and vegetable food, though you had no butcher's meat to put into them ?
2. Why would a sick person be pined to death in a very short time if the nurse gave no other food but the strongest beef-tea ?
3. If you had some cold meat, how would you hash it ?
4. Why is tea a very bad thing for old or young people who cannot get plenty of good food ?
5. Why is coffee, as the French and Germans take it, more nourishing than tea ?

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## LECTURE XXI.

### *COOKING (concluded).*

I HAVE told you that the food we eat must be of different kinds—animal, vegetable, and mineral. We will read what is written on this sheet and see what it tells us about animals and plants.

A germ is the beginning of life in all plants and animals.

Plants have organs ; animals have organs.

They are both made of organic matter.

Both germs contain exactly the same substances—oxygen, hydrogen, nitrogen, and carbon.

You all by this time understand that animals have organs, but I do not think you all know that plants have organs. An organ is an instrument or a place where something is done. I will now show you that plants have organs. I hold in my hand a young potato-plant ; here are the potatoes, the leaves, the stems, and the roots. It has just been taken out of the earth. You see there is some earth sticking to these little roots. These roots, which look like fine little white threads, go down into the earth and suck out of it the water and mineral substances upon which the plant lives. These little roots are little pipes, and carry the water and minerals up into the stems and then into the leaves, and to every part of the plant to feed it, just as our blood is carried to every part of the body by the arteries.

There are thousands of little holes, or pores, in every leaf, like the pores in our skin. If you had a microscope, you could see them: remember they are generally found on the

Fig. 34.

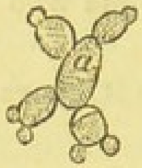
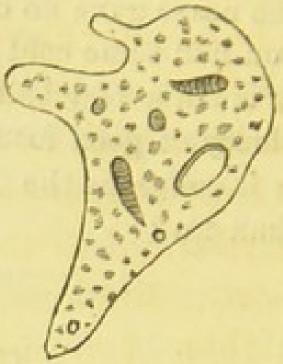


Fig. 35.



Yeast Plant.[1] Amœba—the most simple form of animal life.

under side of the leaf. Plants are said to breathe through these holes. They take in one kind of gas and send out another, as we do through our mouths. You will be surprised to hear that they take in carbonic acid gas, and they send out into the air oxygen gas. If plants did not make use of carbonic acid gas, we and all dumb animals should soon be poisoned, because the air we breathe would become quite full of it. The Almighty allows nothing to be wasted; He has good use for everything He has made.

You see that plants have organs, for I have just named three—the roots, stems, and the pores that cover principally the under part of the leaf. I should like to tell you a great deal about plants, as they are so wonderfully and beautifully made. I should like you all to have window-gardens, as children have in London, and receive prizes for the boxes of flowers that have been most carefully nursed. They require great care and soon die if they are not watered. When any part of a plant dies, it turns to corruption, just as the dead part of an animal would; and while it is dying, it gives off very poisonous gases. At last it returns into oxygen, hydrogen, nitrogen, and carbon; these are the four substances that both animal and vegetable germs are made of.

[1] It must be remembered that these figures represent the objects very much magnified.

I hope you will never eat any fruit like these gooseberries, which are decaying, or, as you would say, going bad. The poisonous gases that are in these dying gooseberries closely resemble those made in an animal when it is dying or turning into corruption. These gases and the poisonous germs that live in corruption will give you diarrhœa or cholera. If people understood that it is as dangerous to breathe the air that comes from a decaying plant as it is to breathe the air that comes from a dead animal, they would not put dead vegetables, such as potato-peelings, old cabbages, &c., into a pail and let them stand in the kitchen under the sink, or anywhere in the house. Middens, or refuse heaps, are dreadful places, for on to them fish-bones, vegetables, and all kinds of dead organic matter are thrown. A delicate person might catch a fever by even passing near such a place. The same might happen in passing a cesspool or a river in which there is organic matter. It is disgraceful to see some parts of our river and canal in Leeds. If you venture to stand a moment, and look at them, you will see gases bubbling up that come from dying organic matter that is slowly floating down, making the air unbearable. Even in lovely country places, where the air ought to be so fresh and sweet, fevers break out, because people have middens, pig-styes, and dung-heaps close to their cottages. Farm-houses are often unhealthy because the farm-yard, stables, and cow-houses are kept dirty. The manure and other dead organic matter becomes liquid, and runs all about, and often finds its way into the well which supplies the house with water. Streets that are badly paved or are not paved at all have deep holes in them: these holes become filled with dead organic matter made liquid by rain. Such streets are a great reflection on any town council, as they cause fevers by filling the houses near them with poisonous gases. Courts and alleys are very unhealthy places, and ought not to be allowed, because fresh air cannot pass through them and kill the poisonous germs that always collect wherever dirt exists.

I must now mention a very dirty and disagreeable habit that children have in schools of washing their slates with their own saliva. Spittle, or saliva, you know, contains organic matter as it comes from our bodies. Many children have caught diseases by this practice. The slate you used to-day, and cleaned in this dirty manner, will be used by some one else to-morrow, and if you were recovering from scarlet fever, the child who used your slate would catch the same fever. Sore eyes, as well as fevers, have been spread throughout a whole school by this dirty habit. I hope soon to see in all our Board schools that sponges and water are fastened to every desk, and that the children will be obliged to use them.

Sweat is dead organic matter. People ought never to sleep in clothes they wear by day. Night-clothes should always have fresh air during the day. At our house we always sleep with our windows open about an inch or two at the top. Directly we get up, we have the bed-clothes turned down and the windows opened wide. Then the oxygen comes in and gets into the bed-clothes and purifies them.

Do you not know how much sweeter clean clothes smell that have been put out of doors to dry than those that have been dried indoors? I am surprised to see in many houses that the beds are made directly we leave the bedroom. They ought never to be made until the beds and the clothes have been well aired. Feather beds are dirty things; they ought to be frequently exposed to fresh air, because a great deal of dead organic matter is often left on the feathers when they are put into the bed-ticking. Remember that the organic matter that is in dirty beds, bed-clothes, or wearing-apparel returns into the blood through the pores of the skin as well as through the lungs when we breathe. Carbonic acid gas, you know, kills us by sending us into a sleep from which we never wake, as it did the two sailors belonging to the French schooner 'Jeanne Roberts' about a month ago. These men, finding the night very cold, determined to keep themselves warm by shutting up the chimney and every hole, so that no fresh air could enter. In the morning they were found dead; they had been killed by breathing the carbonic acid gas that had come out of their mouths.

The poison from decaying organic matter destroys life and health much more slowly than carbonic acid gas, and in a much more dreadful way, because it injures the brain. People become miserable, and sometimes mad. They lose their appetites and long for drink, which only makes them worse. Courts of justice like those in our townhall, where the assizes are held, are filled with crowds of human beings, many of whom have on dirty clothes. Architects, gentlemen who build these courts of law and other grand buildings, do not yet understand how to ventilate such places. Judges and stipendiary magistrates often suffer very much from bad health because they are obliged to sit day after day and month after month breathing air poisoned by organic matter. About a year ago a celebrated judge, it is supposed, lost his life from this cause. His brain became diseased; he lost his senses, and killed himself. If gentlemen who only spend a part of their days in grand buildings are killed by bad air, what is to become of poor men, women, and children who have to live night and day in air much worse than that which is to be found in a court of justice? One sleeping-room sometimes holds three or four families. A respectable cobbler or tailor in London will carry on his trade in the only room which he and his family—perhaps seven children—have to live in by day as well as by night. Just fancy for a moment how dreadful the air in that room must become by the morning. Even should the parents wish to open the window at the top, they cannot do so, for in the miserable dwellings for the poor windows are seldom made to open in this way. We cannot wonder there is always so much fever, scrofula, and preventible disease, when we know how people are crowded together. Fathers and mothers will not put up with these miserable homes when they know what I have told you during my lectures. The air at the bottom and top of all rooms is the least pure; for this reason people should neither sleep on the floor nor allow a baby's cot to stand on the floor; it should always be put on a table or raised in some way.

Germs grow quickly in all organic matter, but they grow the quickest in liquids. Milk, you know, is organic matter; it is therefore very dangerous to leave milk, or any solid or liquid food, in a sick person's room, for the germs that are in the air may fall into this food. Should anyone eat this food, they would very likely take the fever, or whatever the complaint might be. Last autumn, in London, in the parishes of St. George, Hanover Square, Marylebone, and Paddington, there were no less than 104 families who were seized with typhoid fever. It was found that ninety-six of those families had all had their milk from one dairy. When the health inspector went to examine the dairy, he found that typhoid fever had been in the farm-house where the milk came from, and all these cases of typhoid fever had been caused therefore by drinking this milk. Very often milk, as we know, is mixed with water. Should this water have been poisoned by organic matter from a drain or farmyard, the milk with which it is mixed may give disease.

Jugs, or any utensils that hold milk, particularly feeding-bottles for infants, ought always to be washed out with *boiling* water, because boiling water kills all animal and vegetable germs. Warm water only makes them grow. It is sad to think how many little children suffer and die in the summer from bowel complaints, because they have drunk sour milk. Whenever milk is sour, you know directly that germs are growing in it. The feeding-bottle which I fear is most used is the one that has a long india-rubber tube. Some of the milk, in passing through this tube, is changed into a poisonous gas called sulphuretted hydrogen. In addition to this, the milk sticks to the inside of the tube and becomes sour and full of poisonous matter. No nurse, however careful, *can* clean out this tube, for if boiling water were poured through it, the india-rubber of which the tube is made would be spoiled. In 1871, 471 little infants died in Leeds under a year old of diarrhœa. Mr. Wheelhouse believes these tubes to be the cause of hundreds of cases of diarrhœa and of many deaths every year. The only safe feeding-bottle is the old-fashioned one that has a teat over the glass mouth, and no tube. The teat can be put into boiling water, and thus made quite sweet.

It is quite impossible to cook well unless all the saucepans and utensils you use are perfectly clean. Every saucepan ought to be washed out with boiling water; and the water ought to have some soda in it, because you know soda will take away all the grease that may be in the saucepan. Spoons, forks, basins, dripping-pans, gridirons, must also be as carefully washed as the saucepan. Some people will tell you that it is not right to wash a dripping-pan or a gridiron very often, as they ought to be greasy. On the contrary, they ought to be washed directly they have been used, or the dripping will be very bad and unwholesome. A little bit of dead organic matter left in a saucepan will spoil the flavour of any food that is put into it. Grease is organic matter. My cook tells me that she never uses a saucepan without putting her hand into it, because she can tell certainly by that means whether it is quite free from grease.

The outside as well as the inside of a saucepan ought to be washed, or the smoke and soot will cover the outside, and prevent the heat from passing through to heat the food. This pan, you see, is a clean, bright tin one. The water in it is boiling. You could not bear to keep your finger one instant upon any part of it; but just cover it with soot, or put a thick coat of soot on your hand, and you will find that you could then hold the saucepan on your hand very well for some minutes. This will show you how soot keeps out the heat; and you can therefore understand that a saucepan covered with soot will not receive as much heat as a clean saucepan, and the water in it will not boil so quickly. With a bright kettle, and a very little bit of bright, hot fire, you could boil some water very quickly.

Dirty saucepans make dirty hands, and dirty shelves and walls which they hang by or rest upon. A cook who keeps everything she uses clean, saves time, her own clothes, her master's coals, and the food she cooks. The bad and wasteful English plan of putting a saucepan filled with food on a fire, to boil away for a long time, not only spoils the food, but spoils the saucepan. The food gets burnt, and sticks to the bottom and sides, and is most difficult to scrape off. I once saw a kitchen-maid whose nails were quite worn down to the quick by trying to scrape it off. If any of the old burnt food is left in the saucepan, which it must often be, when put on the fire, then the fresh food will take the flavour of the burnt grease and be spoilt.

I once heard a professed cook say to her pupils, 'When you want to fry fish you must first let the fat boil, and more than boil.' Now, if fish or any food were cooked in boiling fat, it would be spoiled and burnt to a cinder. Fat is a difficult substance to cook. Burnt fat is very difficult to digest; pancakes and fried fish are considered trying to a delicate stomach. Water boils at 212°, but fat does not boil until at 600° or 700°. Fish, veal cutlets, and all kinds of food will be beautifully browned when the fat is at 350°.

The cook will now fry this piece of fish, called a fillet of sole, in this fat; you will see by the thermometer that the heat of the fat is what I have already named—350°. Directly the fish is nicely browned she will put the frying-pan on to the hot hob, and let the fish remain there until it is done. Fried fish, like all other food, ought to be gradually cooked, not fried in boiling fat.

I have told you that the Paris and the Vienna bakers make the best bread. The simple reason why they surpass the bakers of all other countries is because they use a thermometer, and find out by it when the oven is at the exact heat it ought to be before they put in their bread. In this country, bakers gain this information by many little guess-work schemes, such as our cook, who is an excellent bread-maker, employs. She puts her hand into the oven to feel how hot the air is. As her hand is sometimes very hot, and at other times very cold, she cannot always find out the exact heat of the oven. When her hand is very hot, the oven will not seem as hot as it really is; if her hand is very cold, the contrast with the hot oven will make the heat seem greater than it really is; and in this way she may fail to judge the heat of the oven rightly, and then her bread will be spoilt. When the dough is put into the oven, the heat ought to be about 570° Fahr. In about five minutes the heat should gradually grow less, to between 430° and 420°. When you put the dough into a properly heated oven—570° Fahr.—the starch grains swell in the dough and the yeast plant continues to grow, until the heat in the air in the oven has spread throughout all the dough, and then the yeast plant is killed. It will take about five minutes to do this. Then the oven should be made cooler by a great many degrees; let the heat go down until it is about 420°; then the bread may bake or cook gradually. If the oven is not hot enough at first (570°), the yeast goes on rising or growing, and the bread becomes full of holes like a honeycomb. Directly we see such bread we say it has not been well baked.

Every oven ought to have a special arrangement for the use of a thermometer. It is very difficult now to place one conveniently. When I was in Paris this autumn I was kindly taken through the kitchens of the Louvre Hotel; there I saw the oven was provided with a thermometer attached to the outside. The maker of this oven is A. M. Lesobre, 17, Rue de la Vieille-Estrade, Paris. I also found that all the meat was roasted at a splendid open fire. No meat can be properly roasted in an oven. The fresh air that surrounds the meat has a peculiar and healthy effect.

Home-made bread is more wholesome than bought bread, because bakers often add alum to make bad flour appear white and good. Bakehouses are too frequently dirty, unventilated cellars, in which the air is most impure.

This is my last lecture on cooking. I hope you have all learnt by this time the value of the thermometer. It is not at all an expensive instrument. Messrs. Harvey & Reynolds, Commercial Street, Leeds, sell some, like this I have used, at 3*s*., which go up to nearly 700°. With one of these a cook could boil and fry every kind of food. I hope that there will soon be one in every kitchen, and that all young girls will be taught to use them. A thermometer that goes up to 600° will answer all cooking purposes.

### *Things provided for the Lecture.*

A frying-pan.
Some dripping for frying the fish.
Fillet of sole (with seasoned bread crumbs and egg all ready prepared).

### *Questions for the Twenty-first Lecture.*

1. Can you tell me what organic matter is?
2. Why is it dangerous to drink or eat any food that has remained in the room of a sick person who has had a fever or any contagious complaint?
3. How would you clean a gridiron, dripping-pan, or any saucepan so that it should not be the least greasy?

4. Why is it necessary to clean a saucepan outside as well as inside?
5. How would you find out the proper heat to fry fish or any food in so as to make it a beautiful brown colour?
6. Why do the Paris bakers and the bakers in Vienna make the best bread?

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## LECTURE XXII.

### *THE NERVES AND THE SENSE OF HEARING.*

To-day I am going to explain the organ of hearing. Before I do so I must tell you a little more about the nerves. They may be compared to the springs in a watch. When a watch-maker has made all the wonderful parts or organs of a watch, they would not move unless he put some springs which keep the organs going. Our nerves are the springs which are fastened to all our muscles, and by this means our limbs are made to move. Those nerves that spread through our bodies come out from the spinal cord, which passes down the backbone, or spinal column. There are, you know, twenty-nine bones in the spine. At every joint a pair of nerves come out, one on each side of the spine between the vertebræ. These nerves spread out all over the body like a fine white network. Look at this diagram (page 67),[1] and you will see them. In this picture of the spinal column (page 66)[2] you may see how they come out between each pair of vertebræ. Each spinal nerve is really made up of two sets of cords wrapped up side by side in a sort of sheath. One set of these cords forms the nerve of feeling, the other the nerve of motion.

The spinal cord, you know, is also connected with the brain. When anything happens to the outside of the body, the nerve of feeling takes the news of it up to the brain; and then the nerve of motion carries back directions what to do, and puts our limbs into action.

For instance, if you put your hand on anything hot, the nerve of feeling in the hand sends a message up to the brain to say that touching this hot thing hurts your hand. If it is burning hot, the brain sends back a message by the nerve of

[1] Marshall's diagram, No. 7. [2] *Ibid.*

motion to take the hand off. Sometimes it happens that the nerves of motion become killed or paralysed for a time by a stroke or a fit of paralysis, while the nerves of feeling are not at all injured by the fit. This once happened to a man. He could not move any limb, not even his tongue to speak, but all the time he could hear, see, and understand what the people did and said who were standing round his bed. In a few days his nerves of motion recovered their power, and then he told all those who had been in the room how dreadful it had been: for he had understood all they had said, and they had talked about a great many things of which they would not have spoken had they known that he could understand. Nurses and friends should be very careful not to talk before paralysed people when they have lost their speech.

We have some nerves that are called voluntary nerves—that is, nerves which give us the power to move the limbs to which they go; for instance, the nerves in my hand and tongue are voluntary nerves. I call these nerves into action when I determine to move my hand, but I do not of my own accord excite the nerves that make my heart beat so regularly. If it stopped beating for a few seconds I should die. Lest I should forget to excite these nerves upon which my life depends, the Almighty does it for me. Great fear makes us grow very cold. Sometimes the muscles become quite paralysed by fear, and they cannot move. The heart then ceases to beat, and we die. This is how people are killed by fear.

How very cruel it is to frighten a little child or any dumb animal! It is also very silly to try and make a child or a dumb animal do anything by fear; for we all know that when we are very much afraid we lose our senses and the power of doing anything. Nurses who frighten children are not only very cruel but very silly, for in the end they have much more trouble with the children than if they had treated them kindly and sensibly.

Mr. Wheelhouse, the doctor, was once sent for to a little boy who had the croup. His nurse or parents had been in the habit of telling him that if he was a naughty boy the doctor would come and cut him up. When the doctor did come, and perhaps might have saved his life, the child screamed so fearfully that Mr. Wheelhouse was obliged to remain in another room while the child was dying. I am afraid that a great many children are made idiots or weak in mind by fear.

When the mind is troubled and weakened, all the organs become weakened too. It has often happened that a person who was just going to sit down to a good dinner received bad news. Instantly after hearing such news even the smell and sight of the good things became disagreeable to him. This is the reason why people grow thin when they are unhappy. They lose their appetite and cannot eat. When our minds are troubled, and we are unhappy, riches and ease bring us no comfort. The only way to cure unhappiness is to work. Try to do something that will help other people; get plenty of fresh air and exercise. A poet has said that our nerves are like a stringed instrument called a harp. He says—

> Strange that a harp of thousand strings
> Should keep in tune so long.

You must often have heard people say, 'I am quite unstrung; my nerves are shaken.' It is quite true that the nerves of people who sit in bad air, such as is to be found in crowded schoolrooms, workshops, theatres, and courts of justice, become very irritable and shaky; though these people feel very weak, nervous, and cross, they cannot bear to be quiet. This is the state of mind that leads people to drink and take spirits. Alas! by doing so they only add one poison to another; for spirits, you know, at last make the nerves so weak that the whole frame trembles from head to foot. Bad air, again, is very trying to little children. They are often required to sit still with their arms crossed for a long time together. This position contracts their lungs, while the bad air in the crowded schoolroom, where they have spent several hours, naturally makes them restless and irritable. This bad air has the same effect upon teachers, who are not then disposed to be very gentle to the children under their care.

Toothache and tic are complaints sometimes caused by weak nerves. You know there is a nerve in every one of our teeth. Little children who live in bad air suffer dreadfully while they are cutting their teeth, but children who live in the country and have good air do not suffer half so much. If properly fed and nursed, they ought scarcely to suffer at all. Doctors say that a great many more children die in large towns than in the country. The nerves in their teeth, being weak from bad air and bad food, cannot bear the pressure of the gum, which becomes very much swollen and inflamed. Directly a doctor lances the gum and lets out the blood the pain goes away, because the gum no longer presses on the nerves. It is a pity that so many mothers are afraid to let their children's gums be lanced, for this simple operation prevents convulsions and a great deal of suffering.

Oxygen strengthens and tightens the nerves just as the tuning-key tightens the strings of a harp and puts it in tune. Don't you know how cheerful and good-tempered you feel when you have been out for a long walk in the country, and how quickly you fall asleep when you go to bed? What a pity it is that mothers do not try and give their children fresh air, instead of buying soothing syrups to make them sleep! There are hundreds of these dreadful syrups, and in every one of them there is laudanum. It is nothing but the laudanum that sends the children to sleep. Only a few weeks ago a friend of mine heard a lecture that was given by a celebrated doctor in a lunatic asylum, a place where mad people are kept. He said that people now drink a great deal of laudanum, or swallow opium, from which laudanum is made, and that this drives them mad. Worse than this, the quantity given to little children by their mothers is something immense. Laudanum deadens the nerves, so that they can scarcely move. The appetite goes, and the child who has continually taken laudanum is pined to death.

A friend of mine went into the house of a poor neighbour some months since, and saw a poor little infant in its mother's arms trembling like a leaf. She said, 'Oh dear, the poor little thing is going to have a fit.' 'Oh, no,' replied the mother; 'it only does this because it wants to go to sleep.' Another day she went in and found it just in the same dreadful state; this time she saw the mother give it some soothing syrup, and it soon fell asleep. The mother said, 'Oh, it will never sleep without that stuff.' The poor little child was only skin and bone; it has since died. I am afraid that thousands are killed in the same horrible way. I will tell you the following facts to prove the immense quantity of these soothing syrups that are sold. A respectable druggist of Manchester once told Dr. Lyon Playfair that he sold, every week, five gallons of 'quietness' and half-a-gallon of 'Godfrey's soothing cordial.' In Preston it was found that the chemists sold, every week, 70*l.* worth of 'Godfrey's cordial,' 'quietness,' 'child's preserver,' 'syrup of poppies,' and laudanum.

My father was a doctor. He gave us, his children, very little medicine, and begged us never to take any unless a doctor had ordered it. It is only men and women who are ignorant of physiology who will venture to give medicine to their children, or to children who have been committed to their care. I have often heard ladies say, 'My nurse understands all about a baby, and she knows when to give it medicine.' If mothers themselves took care of their children when they were young, neither a doctor nor medicine would often be needed. I perhaps know more than a nurse, yet I should not venture to give medicine to anyone, much less to a child.

It is sad to know that thousands of quack doctors grow rich by selling their pills and lotions, while the people who buy and swallow them grow poorer and more unhealthy. It is a pity that they do not keep their money and spend it on a trip to the country, where fresh air and change of scene might really do their health good. I do hope you will never buy any medicine that is advertised in a newspaper or on a wall; for, you may believe me, no really good and clever doctor will ever advertise the pills and lotions he has made, and say that they will cure all kinds of complaints, without ever having seen the person who was going to take them. How is a person to know what is the matter with himself or his child if he is not a doctor? Even the cleverest doctors say that it is difficult for those of them who live in the house with their patients and see them every day, to find out which of the forty organs is diseased or out of order. The quack medicine you have paid so dearly for may be the very one that you ought not to take, and may hurt the organ that is weak.

People are very foolish to buy hair-washes. They generally contain lead, which is a dreadful poison, and often causes paralysis. I have a friend who used a hair-wash—fortunately only for a short time—and she became slightly paralysed. Lead which is in paint, and sometimes in drinking-water, &c., injures the nerves very much, and gives many painful complaints. Dr. Guy says that early in the eighteenth century there was a dreadful disease in Devonshire. People were first taken ill with a painful colic, next their hands became paralysed, and lastly they were delirious or epileptic, and they died in convulsions. Devonshire is a county where cider is made and the people drink a great deal of it. Sir George Baker, a celebrated physician, determined to find out the cause of this disease. The cider was chemically examined, and it was found to contain lead. The next point was to discover how the lead had got into the cider. It was found that the following things were done by those who made the cider:—The presses in which the apples (cider is made of apples) were put were mended by iron cramps fixed by melted lead. If there was a crack in the press, this crack was covered over by a sheet of lead. A leaden weight was put into the cider to prevent the liquor from turning sour, and lastly the cider was carried from the press in leaden pipes.

Lead can enter the blood through the pores of the skin; that is why hair-washes containing lead paralyse people. Painters, plumbers, type-founders, and all who work with substances that contain lead, should wash their skin frequently, and always wash their hands and faces before eating anything. Some persons are made very ill by remaining in a house while it is being painted, or by sleeping in a freshly painted bedroom.

The sense of hearing, which I am now going to explain, is called a *special* sense. When we hear any noise, the sound of it comes through the air and strikes our ears. You know that if you stop your ears you will not hear anything; but I will also show you that without the air you would be equally unable to hear.

The air about us is made up of very tiny particles of matter; matter means something you can feel or touch. We cannot, it is true, see the air that fills this room, but we often feel it when we are out of doors on a windy day; then it knocks against us so roughly that it nearly throws us down. The air helps us to hear, for when anything makes a noise it knocks these little particles against each other, and they carry on the sound to our ears.

You have all thrown stones into a pond of water, and seen that directly the stone struck the water little rings were made all round the place where the stone fell in. These little rings round the hole spread out one after another like small waves, until they reached the edge of the pond. Every time I speak the air is forced out of my lungs and pushes the air in this room, and little rings or waves of sound are made, that spread out one after another until they reach the walls.

If there was no air, there would be nothing to make a sound, and everything would be silent. You see this glass, and inside it there is a little bell. All the air has been pumped out of the glass. We can pump out air just as we can pump out water. Now I will ring this little bell. Do you hear any sound? No, not any, because there are no particles of air inside the glass to make the waves of sound. When a noise is made waves of sound go through the air in all directions, and some of them get into your ears. You have a great many nerves of sound in your ears; the rings or waves strike these nerves, and they carry the sound to the little centre of white and grey matter that holds the sense of hearing, placed in the back part of the head under the little brain. We have two centres of hearing, one for each ear. We have an outer ear and an inner ear. You can only see the outer ear; it is this curled or twisted piece of flesh. It is twisted because the waves or rings of sound can get into the ear more easily through these curved places. Human beings generally cannot move the outer ear, but a great many animals can do so. A horse pricks up its ears, so does a donkey.

All animals who have to escape from their enemies by running away can fortunately hear very quickly, such as a hare or a rabbit. Sporting dogs have very large outer ears.

The dogs called rat-catchers have very large outer ears, because they have to listen at the mouth of the hole where the rat lives, to hear whether the rat is at home. If the dog hears a certain noise, he knows the rat is inside, and then goes into the hole to try and catch him. Rat-catchers also want these long ears to prevent the earth that they scratch out of the hole from getting into the ear.

A great many people cut dogs' ears; it is a most ignorant and cruel practice. It is done to improve their beauty. Do you think that animals would have long ears but for some wise purposes, or that men can improve their beauty?

Landseer, the celebrated painter of animals, was walking down a street in London, and met a man who was selling dogs. To his great surprise and delight, none of the dogs had their ears cut. He asked the man the reason why. "Don't you know that Landseer, the great painter of dogs, says they ought never to be cut, and he will not paint any dogs whose ears are cut?" Landseer told the man that he was speaking to that painter, and they were both equally pleased to have seen each other.

Now, there is a passage, about an inch long, that goes from the outer ear to what is called the middle ear; this middle ear is placed inside the bone of the skull which is called the temporal bone. You can feel this bone behind your outer ear; it is very strong. The end of this passage is covered by a little piece of skin, so that nothing can go through it. Inside this passage there are a great many hairs and a good deal of wax. These hairs and wax prevent little insects and dust from getting in. You must never pick your ears with anything. Mothers, I hear, clean their children's ears with a pin, which is a most dangerous practice, as the pin might burst that little skin, called the drum, that covers the end of the passage. If you could look behind the drum, you would see a little room, called the middle ear, which is filled with air. In this room there are three curious little bones. These bones are connected together by little joints. One little bone is like a hammer, another is like an anvil, and the third is like a stirrup into which you put your foot when you ride on horseback. One of the bones, the hammer, is fastened to the drum or skin that covers the end of the passage, and the last bone, the stirrup, is fastened to another little skin that covers a most wonderful winding passage in the inner ear. One part of this second passage is called the labyrinth, because it twists about; and the other part of the passage is called the shell, because the passage winds about in the shape of a snail's shell. In these passages there is a liquid like water, and then there is a bag which is filled with the same fluid, and floats in the watery passage. A great many nerves of sound, that look like fine threads, cover the floating bag, and go along inside the passages until they reach the collections or centres of white and grey matter which are placed in the back part of the head. The nerves of sound are placed in water, because water carries sound much more quickly than air.

Now I have only to describe how the air moves these nerves of hearing. When the waves of sound rush into the first passage, they strike against the piece of skin that covers that passage, called the drum, and make a noise just as if you struck a drum with a stick. This skin moves and pushes those curious little bones that lie in the little room that is filled with air on the other side of the drum. They all begin to shake and tremble until they make the air knock against the other little piece of skin, called the oval window, that covers the entrance into that curious winding passage in the inner ear; and then all the little nerves that are in the bag of water begin to tremble, and they tremble so much that they shake the nerves which pass from them, until this shaking reaches the 'centre' of hearing under the big brain. The brain then feels the shaking, listens, and begins to think about what it hears, and then finds out what the sound means.

We all know that children suffer very much from earache. There is no doubt that a great deal of their suffering is caused by the way in which those who have the care of them clean their ears. The only part of the ear that ought to be washed with soap and water is the outside ear which twists about. Great care should be taken to dry *gently* all these twisted parts, and to let no water get into the little hole that leads into the first passage. If the ear is healthy, this passage is never dirty. Nature cleans it out by means of the wax, which grows very dry and falls out in fine powder. If water gets in, the wax is spoilt. People often squeeze up the end of a towel, and push it into the hole ; this presses the wax down upon the skin, or drum, that covers the end of the passage. Air cannot then get into the ear, and the lump of wax gets hard and injures the drum, or causes inflammation, so that the child may become hard of hearing or deaf. An earpick or a pin is sometimes used to take out the wax, and these may also break the drum. A loud and sudden noise has broken the drum, such as the going off of a gun close to the ear. No one ought to be allowed to box a child's ears, because the blow forces the air against the drum just as a loud noise does, and the membrane of the drum may be injured. A doctor tells the following sad story to show how cruel this practice is :—

A boy who had been troubled with sore ears became hard of hearing. His father was in the habit of boxing his ears, because his son appeared stupid and inattentive. The boy died, and it was then found that his ears were diseased. The doctor thought the death might have been caused by the blows the boy had received.

If a child cries when its ears are washed, or does not generally attend to what is said to it, let a doctor look at its ears, for very often this inattention is not the child's fault. When a child has sore ears, or is suffering from ear-ache, apply hot flannels. People often put hot onions, figs, &c., into the ear for tooth-ache as well as ear-ache. No one but a doctor ought to put anything into the ear. Cotton-wool collects in the ear and injures the hearing. When a person is exposed to a draught or cold wind, a handkerchief should be tied over the ear.

I will now let you see and examine this beautiful model of an ear, and I think you will find that all the parts I have described are there.

*Things provided for the Lecture.*

A diagram of the brain, spinal cord, and nerves.
Auzoux's model of the ear.

*Questions for the Twenty-second Lecture.*

1. Why is it very dangerous to frighten a child?
3. Why do a great many more children die in large towns every year while cutting their teeth than in the country?

3. Why are all kinds of soothing syrups very dangerous, and sure to weaken the nerves of a baby?
4. Why is it very unwise to take any quack medicines, particularly those which are advertised in newspapers or on the walls?
5. Why is it very cruel and foolish to cut off the ears of a dog?
6. Describe all you can remember about the sense of hearing.
7. Why is it dangerous to box a child's ears?

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## LECTURE XXIII.

### *SIGHT AND SUNSHINE.*

THE sense of hearing, which I described in my last lecture, is called a special sense, because the nerves of hearing are only, or specially, made to receive and carry the waves of sound. The sense of sight is also called a special sense, because the nerves of sight are only, or specially, made to carry the waves of light. We cannot see with the nerves of hearing, or hear with the nerves of sight. The nerves of sight and hearing have no feeling, like the nerves that are spread all over other parts of our bodies; even the slightest touch hurts these nerves of feeling, but someone might cut your nerves of sight and your nerves of hearing, and you would feel no pain.

I am now going to explain the organ of sight. When I showed you the human skull, you must all have noticed what very deep holes there were in the place where the eyes ought to be. Those holes are called sockets: they are filled with cushions of fat, that have a hole in the middle of them. In these holes the eyeballs rest. The eyeball is round; it has three coverings. I have a large model of the eye, which I will now show you. I can take this model to pieces and show you how wonderfully the eyeball is made, but before I do so let us see what the front part of the eyeball, that we can see. looks like. First, there is the part called the white of the eye, then in the centre of the white there is a clear glass-like part, behind which is seen a coloured ring. In some people this ring is blue, in others it is black, and in others grey or brown; but we all have a little hole exactly in the middle of this coloured ring which always looks black. As all the light that enters the eye passes through this dark hole, it is called the window or pupil of the eye. If you can't see this model, look into each other's eyes, and you will see that your eyes have what I have described. I will now take the eyeball to pieces. It has three coverings. The first one outside is white, and we can see it because a part of this cover comes to the front, and is called the white of the eye. The second covering is black. And now we come to the third or inside covering, which I shall explain first.

The third covering is called the retina, and consists of a transparent nervous substance as clear as glass; but as the eyeball is also transparent like glass, the gentleman who made the model has made the retina look white like ground glass, in order to show how much of the eyeball is covered or lined by the retina. This retina consists of an immense number of threads, which are the nerves of sight. These nerves all join together into this large nerve of sight which you see at the back of the eyeball. This large nerve of sight goes to the portion of the brain devoted to sight, that lies between the great and the little brain. As we have two eyes, we have two such portions of brain. They are called the centres or ganglia of sight. When rays of light have entered into the eyeball through the window, or pupil, they *first* pass through some clear parts, called the humours, and then strike and go through the retina, and then they all sink into the second black covering, which I will now place over the retina. Directly all the rays of light have sunk into this black covering, a perfect picture will appear on the retina, at the back of the eyeball, of all that stands in front of the eye. For instance, at this moment there is a perfect picture painted on the retina of my eye, as on a looking-glass, of this room and every boy and girl before me. The nerves of sight of which the retina is made are very delicate; they cannot bear too much light all at once. What do we do when too much light comes into a room? Do we not draw a curtain, to keep out some of the light? A beautiful little curtain is also drawn for us directly too much light tries to pass through the window of the eye. This little coloured ring I showed you that is placed round the window or pupil of the eye is the curtain, and is called the iris. We have all different coloured eyes, as I said, because we have all different coloured curtains; some are blue, some brown, some black. When the light is not too strong, the window or hole in the centre of the eye becomes large; but when the light is very strong the curtain draws together and makes this hole very small. Have you ever seen a cat's eyes in a dark room, how bright they are, and how large the window, or pupil, looks? A cat can see much better than we can in the dark, because her window can be made much larger than ours, and so lets more light go in.

I will now say a few words more about the first two coverings of the eyeball. The black one, or second covering, is called the choroid, and is filled with veins, arteries, and capillaries. It must therefore be carefully guarded. It is well protected, you see, by the white or first covering, which is called the sclerotic, for it is very tough and strong. I will place it over the black covering. The black covering makes the picture on the retina look more distinct, and it also makes the window, or pupil, of the eye look so black. Over the front part of the eye, where the curtain and window are placed, there is a transparent covering like the glass face of a watch, called the cornea. It also bulges out like a watch-glass, and is fitted into a little groove that runs all round the edge of the white coat, or sclerotic.

I will now explain why we have eyebrows, eyelashes, and eyelids. Inside the eyelids there is a very tender coat or skin, which is quite transparent. The same skin passes over the whole of the front part of the eye. If a bit of dust has ever got into your eye or under the eyelid, you will know, from the pain it gave you, how delicate this coat is. The smallest piece of any hard substance would injure the eye if it remained in it; this skin is therefore made so sensitive and tender that we cannot rest until the hard stuff has been taken out.

Everybody ought to know how to take out anything that has entered the eye. You have only to press a knitting needle or something hard across the outside of the lid at the top, take hold of the upper eyelashes and make the lid turn over the hard needle. Then you will easily discover the substance, if it is sticking, as it often does, to the delicate membrane. A clean quill pen is a good thing to get it out with, if it cannot be gently washed or rubbed off.

On the outside of the eye, in this corner farthest from the nose, are placed our tear-glands. These little tear-glands and other little glands on the inside of the eyelids are constantly forming and sending the watery fluid known as the tears over the front of the eye. The lid moves this water about and washes the cornea with it, so that there may be no dust on it to prevent the light from passing through the window, or pupil. This is what happens when we wink. Perhaps you do not know that you wink your eyes a great many times in a minute. The dirty water runs out into two little holes; one is on the top lid and the other on the bottom lid. In the corner of the eye near the nose there is a little tube that passes down into the nose; this tube, or pipe, carries the water away through it. When we cry we always blow our nose; as the tear-glands then send out too much water for the pipes to carry along into the nose, the tears then run down over the cheeks also.

The eyelashes are little brushes that sweep away all the dust that might otherwise get into the eye. The eyebrows also keep off the dust. Grooms, and ignorant people who have the care of horses, sometimes cut their eyelashes. A horse has no hands to rub his eyes with when anything gets into them, as we have. Eyelashes are therefore even more necessary for a horse than for us. This cruel practice makes their eyes inflame. The little red piece of flesh at the corner of our eyes is much bigger in a horse, and is called a 'haw.' This haw grows big and inflamed when the eyelashes have been cut. The same ignorant people who cut away the eyelashes cut the haw too when it becomes inflamed, as they do not understand its use. This piece of flesh in a horse has the power of moving over a great part of the eye, and so rubs off any dust or hard bits that may get into it. Fancy what the poor horse will have to suffer who has been deprived of both eyelashes and haw, when he has to travel over dusty roads on a windy day.

Bad air injures the eyes of human beings and all animals. Little children who live in bad air have a very painful disease of the eyes. Stables where horses are kept are often very dirty. Out of the dead organic matter which often lies in a stable comes a gas called ammonia; this gas makes the eyes very sore. Dark stables are also very bad for horses.

I must not forget to point out the six muscles which are fastened to the back and sides of the eyeball; the eye by means of these muscles can turn to the right and left, up and down, and in other directions. You can see these muscles in this model. I have not told you nearly all I should like to tell you about the eye. I hope when you are older some one will explain the use of this transparent body or humour inside, called the crystalline lens, and many other wonderful things. I do not think I could explain them so that you would be able to understand them yet.

Parents and teachers are not aware that children often suffer from imperfect vision, or are short-sighted. At music lessons, or when they have to read what is written on a black-board, or distinguish the colour of an object, they sometimes appear stupid, and are punished for want of attention. Sometimes, too, they are accused of not speaking the truth when they say they did not see something that everyone else saw. Instead of scolding and punishing, it would be better to be gentle and watch the case, and take the child to a doctor who understands the eye.

The wonderful organs of sight which I have just tried to describe to you would be useless unless there was a sun to give us light. In the dark we can see nothing. I am now going to mention some more of the wonderful things we owe to the sun. Without the sun we should have neither light, heat, the air we breathe, the food we eat, the water we drink, nor the coals that burn and make our fires. No animal or plant can live without the sun. I will first explain why plants must have sunshine. Before I do so, I had better remind you that carbonic acid gas is made of oxygen and carbon. I told you that the under part of every little leaf is covered over with organs called pores, or mouths, through which a plant gives off oxygen gas and takes in the carbonic acid gas we send out of our mouths, which poisons us and all animals. The plant does not like the carbonic acid gas any more than we do, but it likes the carbon that is in the carbonic acid gas. If the sun shines on the leaf, some of the rays of the sun separate the carbon from the oxygen, and the leaf then sends out all the oxygen it does not want into the air for us to breathe, and keeps the carbon for itself to help to make the grains of starch or the sugar which produce fat when we eat vegetables. All plants, or vegetables, which are the same things, die when there is no sun to change or separate the carbonic acid gas into oxygen and carbon.

When human beings live in dark places where the sun cannot come, their minds grow weak, and their bodies become unhealthy, and they fade like plants. Switzerland is a country where the mountains are sometimes so high that the valleys, or places that lie between two high mountains, get very little sunshine, and the air in them is often very close. Some of the Swiss people who live in these deep valleys have large swellings in their throats, and they lose their senses and become idiots. For a long time doctors could not find out why these poor people were so much afflicted in body and mind. At last it struck them that these diseases came because they had not enough sunshine to purify the air. Hospitals were therefore built high up on the mountain sides, where plenty of sun could shine upon them and get into the rooms. When the idiots and people with swollen throats had been in these hospitals for some time, both body and mind grew much stronger, and they were able to work like other people.

The Rev. J. H. F. Kendall, of Leeds, told me he once suffered from a sore throat for several months; no medicine did him any good. At last it occurred to him that the room he always sat in got no sun. He removed into another room upon which the sun was constantly shining. In a very short time he lost his sore throat. Florence Nightingale, who went out to nurse our poor wounded soldiers in the Crimea, found that the sick and wounded recovered very quickly on the sunny side of the hospital, but a great many of the poor fellows died who were obliged to lie on that which had very little sun. It is very unwise of people to pull down their blinds to save their curtains and carpets, and to shut up their sunny sitting-rooms and only use them for grand parties, and live in dismal rooms every day that get no sun. No carpets, curtains, or furniture can be sweet and wholesome unless the sun can get to them. That is the reason why best rooms that are only used for parties smell so fusty and disagreeable when you go into them.

I must now explain how it is that the sun gives us the water we drink and the air we breathe. This instrument, called an 'orrery,' which I have before me, represents our earth and the sun. This small round ball is our earth, and the large one is the sun. You see, if you look at our earth, that there is a great deal more water than land upon it. The heat of the sun strikes on to our earth and warms both the sea and land. The sun's rays pass into the sea and make the top of it very warm, so warm that some of the water is turned into vapour. The vapour being light, floats up into the air for a very great distance, many, many miles; some of it then becomes cold, and falls down in rain. If the rain falls in a very cold country, like Russia, the vapour turns into snow and ice, and rests upon the mountains. Some of the ice and snow is constantly melting, and the water thus formed runs down the mountains in little streams. These little streams unite together and make a river. The river runs on until it reaches the lowest level—that is, the sea from which it came. There is not a drop more water on the earth or in the sea or the air than when the world was made, because the water that is taken up from the sea into the air is always falling down again and finding its way back to the place it came from. It is therefore said to circulate.

The rain that comes down in England upon the mountains does not often become frozen on their summits, as our climate is not a very cold one. Some of the water as it runs down the hill-sides gets into the earth and runs on till it meets with a piece of clay, which will not let it pass through, but holds it as if it was in a basin, and this basin is called a well. Well-water is generally very pure water; but take care you never drink water out of a well which is placed near a large town, a drain, or a churchyard, for sometimes the dead organic matter from the churchyard and the poisonous gases get into it. This happened in London at the time of the cholera, twenty years ago. The water of a well in Golden Square looked so bright and sparkling that the people thought it must be very pure water. When Dr. Lankester examined it he found a kind of fungus or yeast plant growing in it, and a great deal of dead organic matter that had come from the churchyard. It was shown that all the people who drank water out of this well suffered from cholera. Whenever you have the least fear that water is not pure, boil it well. A filter only cleans the water; it cannot kill any germs. Nothing but boiling water will kill them.

Before I conclude my lecture I will just wind up this orrery; it goes by clockwork. Our earth turns quite round on its own axis in twenty-four hours. That half of the earth which is turned towards the sun will have daylight; the other half which is turned away will be in the dark, and therefore it will be night.

You also see that our earth moves round the sun. As we look into the sky it seems as if the sun moved round the earth. We are all taught at school to say that the sun rises and the sun sets; but this is an untrue statement, and misleads children very much. It is the earth we live on that may be said to rise and set, because it turns round so as to present any given part to the sun, and then from the sun once in every twenty-four hours. I was very anxious to bring this orrery on purpose to make you understand this fact.

### *Things provided for the Lecture.*

An orrery.
Auzoux's papier-mâché model of the eye.

### *Questions for the Twenty-third Lecture.*

1. Describe all you can remember about the special organ of sight, and explain why the eyelashes of a horse ought never to be cut, nor that part in the eye called the haw.

2. Name some of the complaints that human beings suffer from who live much in places where very little sunshine can come to them. When Florence Nightingale nursed our poor soldiers in the Crimean war, what happened to the men who lay on that side of the hospital where they got scarcely any sun?
3. How does the sun give us the carbon from which the fat is made that burns in our bodies, and how is it that the sun's heat helps to give us the water we drink?
4. Why is it dangerous to drink water that has been got out of a well that is placed in a town, or from a well that is near a churchyard or any drains?

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## LECTURE XXIV.

### *THE VOICE.*

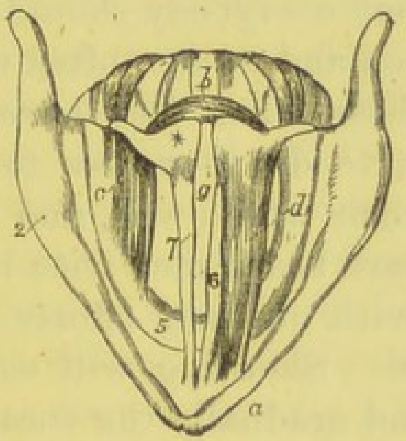
I SHALL begin my lecture to-day by describing the beautiful little musical instrument or organ by which the voice is made.

At the top of the windpipe, just at the back of the tongue, there is a small box, made chiefly of cartilages and muscles, called the larynx. Here is a picture of the larynx. It looks like a Jew's harp, only that it has two strings instead of one. I daresay you have noticed that men have a lump in their throats. This lump is called Adam's apple, and it is made by this pointed part of the box, which comes to the front of the throat. These two strings or cords in the interior of the larynx, which go from the front to the back, are called vocal cords.

Men have made a great many different kinds of stringed instruments, such as the harp and fiddle. Here is a harp. A harp has a great many cords or strings, and they are all of different lengths, and each cord has a different tone or sound. I will first strike the longest one; the tone you hear is a low one. Now I will strike the shortest one, and you will hear that it makes a high tone. The musical instrument in our throats, I told you, has only two strings. The strings are both of the same length, and yet we can make almost every different tone that a harp or any instrument that has ever been made can produce. Don't you think this is very wonderful?

I will now explain to you how we are able to make our two strings either short or long. I told you that the box, or larynx, across which the two vocal cords are placed is made up chiefly of muscles and cartilages. Some of these muscles are fastened to the cartilages and to the vocal cords, and they can draw the vocal cords out and so make them long, or shorten them by pulling them in, just in the same way that the cords or strings of a harp can be made tight or loose by turning these screws. When we sing a high note we stretch out our throats and hold up our chins; by that means we help to tighten or

Fig. 36.




View of the larynx, as if you were looking down through the mouth into the windpipe. The back of the larynx, or musical box, is that part marked *b*; the pointed part comes to the front of the throat, and is called Adam's apple *a*. 7 and 6 are two cords called the vocal cords; between these two cords there is an opening called the glottis *g*. It is through this hole that the air enters and passes out from the lungs. The muscles that are in the larynx make the vocal cords come close together or draw them apart, make them loose or tight.

screw up and shorten the cords. Look at a little bird when it is singing high notes, or a cock when it is crowing, and you will also see how much they stretch out their throats. A woman who is singing a high note or scolding some one across a room or street does just the same thing. When we speak low, we let our chins fall; the cords then become longer, and the opening between them is larger.

When we play on a harp or fiddle we strike the strings with our fingers to make them shake or vibrate, and then a sound comes from them. What strikes against our vocal cords? It is the air, as it comes out of our lungs, that strikes against them and makes them shake or vibrate, and cause a sound. The air does not make the cords vibrate as it goes into the mouth, for while we are taking in air and filling our lungs, our vocal cords are wide apart, and make an opening in the shape of the letter V. The wide part is at the back of the throat. It is impossible to speak or sing properly unless there is plenty of air in the lungs to come out and strike against the cords.

Great fear takes away the breath. People who stammer are nervous. They are afraid they will not be able to speak, and this fear takes away their breath and their presence of mind. They either try to speak when their lungs are empty or when they are taking in breath; then of course they stammer, or fail to speak their words as they ought to do. It is very necessary that everybody should learn to speak well and distinctly, for men and women often want to make a large number of people hear what they have to say. It will be impossible for them to do so unless they have been taught how to pronounce their words well, and where they ought to take in breath. I have heard men with loud voices speak in our town hall, but with all their efforts only those tolerably near could hear them. Shouting will not do; shouting only injures the lungs and gradually the vocal cords. Clergymen and teachers often suffer from throat complaints, because they were not taught early how to manage their voices. A friend of mine, who was the cleverest and kindest teacher I have ever known, completely lost her voice because she had thought it necessary to speak loudly. For a year she was obliged to give up teaching. When her voice returned she came back to the school, and ever after spoke in a low tone. She told me she found the children could hear her better than they used to do, were much more attentive, and the school altogether was in better order.

To speak distinctly and with a pleasant voice you must know how to pronounce the vowels a, e, i, o, u. For instance, do not you think it sounds much better to say 'No, I won't,' than 'Na, ar wearnt'? To say 'Na, ar wearnt,' you are obliged to make an ugly face and an ugly sound, and your voice cannot be heard at so great a distance as if you had said 'No, I won't.' The last letter of a word, if it is a consonant, ought to be distinctly pronounced. Breath should be taken in at all the stops; and, above all, the reader must not stoop, because then the lungs are squeezed together, and they cannot hold all the air that is necessary. Children who live with people who are gentle and speak softly, learn to speak softly too. It is true that some voices are sweeter than others; but every voice can be trained to give out pleasant tones. Angry tones spoil the delicate vocal cords, and put them out of tune, and by the time a child has grown up their sweetness has gone for ever.

Mothers have the power of teaching their children to play on the most perfect instrument that has ever been made. No instrument invented by man can produce such sweet tones as those which come from the human voice; you will often hear people say, after hearing a woman sing, that her voice was divine. In a sick room a sweet voice will often soothe suffering when no medicines can bring relief. A little infant, who cannot understand a word that is spoken, can understand and be comforted by the sound of its mother's gentle voice. I believe the most hardened criminal can only be made to feel really sorry for his cruel deeds through the gentle tones of a voice that will tell him they come from a heart that is equally soft and tender.

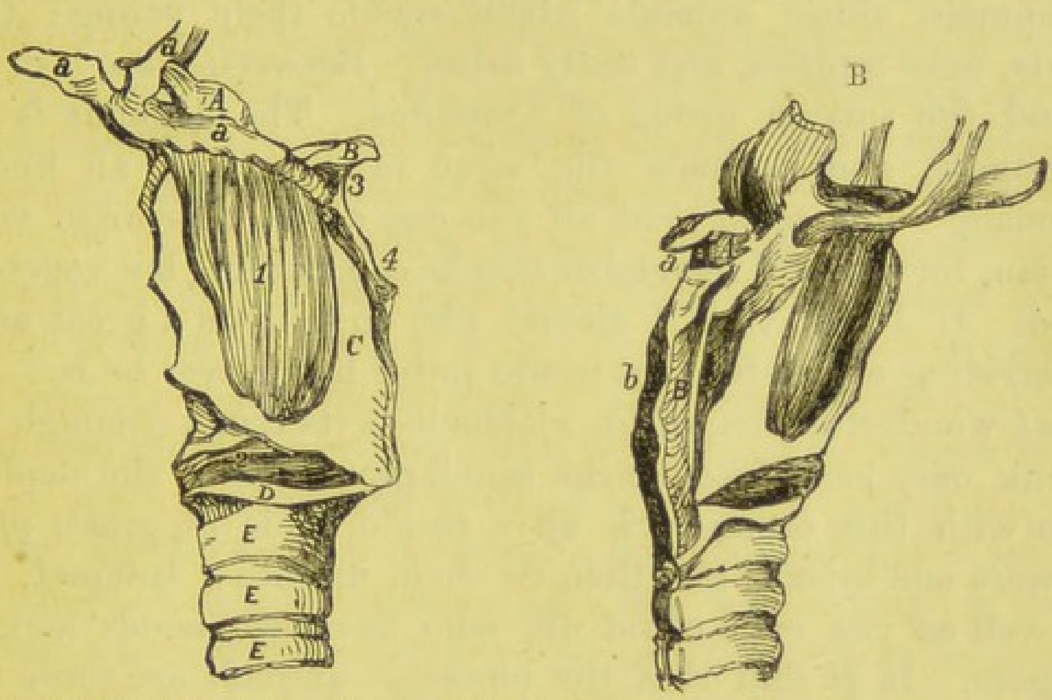
Two or three years since, when I was going over a public institution for certified children in this town, I wished to see the cell where naughty children were put. When the door opened, I saw a poor little deformed hump-backed girl of ten. I only said two or three words to her, and she burst into tears, and cried as if her heart would break. I never felt more unhappy than when the key was turned in the lock, and I had to leave this poor little creature to spend the rest of the day all alone in a small room which did not even contain a chair. It appeared that she had broken a medicine bottle, and had denied having done so. The matron said she was a most hardened and wicked child; she had been in the institution for three months; up to that time she had usually spent her nights on door-steps! Poor little creature, I thought; after all your evil training and hard life, your little heart is softer than the matron's.

A kind heart, gentle manner and voice, are to my mind indispensable qualifications in those who undertake the care and education of young people. Unless a child can dare to show its failings and ask questions, it may appear good and pass every standard, but it will go out into the world morally weak, possessing nothing worthy of the name of education in its true and highest sense.

The fiercest animals have been known to grow calm on hearing the voice of a person who had been kind to them. Horses are so gentle and affectionate that they can be perfectly managed if addressed gently. For that reason it is said that women ought to take care of them. A groom's work is not hard compared with the work that many women have to do.

A great many vertebrate animals have the wonderful little instrument in the windpipe called the larynx, which makes the voice. It is a most delicate organ, and if the throat is forced into an unnatural position, it is soon injured. This is easily seen in the case of horses. Some spirited horses naturally hold their heads up, and arch their necks. Ladies and gentlemen admire horses that do this, and try to make their horses do the same by putting on a bearing-rein, which fastens the head back. By pressing the head back in this way the shape of the larynx is quite altered. Here is a picture of the larynx of a horse that had been injured by a bearing-rein, and here is one as it ought to be, taken from the 'Illustrated Horse Doctor,' by Mayhew. In this cramped position some of the muscles cannot work; they therefore grow weak, and at last die away. The opening between the vocal cords grows small, so that a proper quantity of air cannot get down into the lungs. But horses have to go quickly, and they therefore require all the air they can get, so that whatever prevents their getting as much air as possible distresses them very much. If you look at a horse that is dragging a cart up a hill, you will see that it stretches out its neck, as it does nearly all its work by the help of the muscles in its shoulders. A bearing-rein entirely prevents the use of these muscles, and must cause great suffering to the horse. From this cruel practice of using the bearing-rein, the horse after a time breathes very badly, and then it is called a 'roarer.' The very people who have caused it so much suffering and have spoilt it, often sell it to be worked very hard in a tram-car, cab, or cart. Surely this is not the way to treat a faithful servant whom we have ruined. I am glad to say that carters and cabmen very rarely use a bearing-rein. We must hope that gentlemen and ladies will soon become equally wise and humane. Some coachmen make their horses go by jerking the reins continually. This practice, like that of suddenly pulling up when they are going at a great speed, hardens the mouth and injures the throat.

A Fig. 37.




A is the picture of the larynx of a horse in a healthy state. B is the larynx of a horse after it has been driven with a bearing-rein.

I trust that it will soon be considered necessary that all those who have the care of children and animals should first understand physiology and the laws of health. Rich and poor people are now so ignorant about these two subjects, that they think any uneducated boy or girl may have the charge of a child or dumb animal.

*Things provided for the Lecture.*

Marshall's diagram of the larynx.
A small toy harp.

*Questions for the Twenty-fourth Lecture.*

1. Write all you can remember about the organ by which the voice is made.
2. Why is it cruel to drive a horse with a bearing-rein?

## LECTURE XXV.

### *THE TREATMENT OF ANIMALS.*

DURING these lectures you have seen that vertebrate animals have many organs similar to those of human beings, and therefore require very kind treatment and care.

When we go next week to the Museum, I will first show you the animals that have a backbone and a bony skull, of which I have told you there are four great types. First, Mammals, those animals which suckle their young; then birds, next reptiles, and lastly fishes. Between these last two stand the smaller group of Amphibia. The elephant is the strongest, and perhaps the most intelligent of all known animals. You must read all you can about this huge vegetarian, for you will remember that he eats nothing but vegetable food. If I had time I should like to tell you a great many interesting anecdotes that would prove how clever he is. The most wonderful part of an elephant is its trunk; though the trunk only looks like a large round pipe of flesh, the elephant can with this organ pick up a single blade of grass, pluck flowers one by one, and then tie them up into a bouquet, just as well as you or I could do, who have two hands and ten fingers. It is said that the cleverest animals are those that have the finest sense of touch. The elephant is unlike the dog, who forgives his enemies. If anyone offends him, he will not rest till he has been revenged. A man once promised an elephant that he would give him some beer to drink if he would push a heavy load up a hill. When the work was done, the man, instead of fulfilling his promise, only laughed. Directly the elephant saw this, he killed the man.

Dogs are the most faithful and affectionate of all animals; they will die sooner than forsake their master; they are also very courageous. A small dog has been known to attack a tiger, and make it run away. You will find endless interesting stories about dogs, horses, and cats in natural history books.[1] Cats, too, are very clever and affectionate. I cannot

[1] See especially a book called 'Man and Beast,' by the Rev. J. G. Wood.

think why people are often so cruel to them. It is thought that they only love places and not people, but this is a great mistake.

All animals were made for some wise purpose, and it is intended that they should enjoy life. A great many people seem to think that animals were only made for their selfish amusement.

I think it very cruel to keep pets; that is, to shut up animals or birds who ought to be constantly moving from place to place, just for the pleasure of looking at them occasionally, or hearing them sing for a few minutes during the day.

I hope ere long that no person will be allowed to carry wild animals all over the country in shows, called travelling menageries, that are now to be seen at nearly every feast or fair. It is dreadful to think of the sufferings these animals must undergo from being shut up in small cages; but this is nothing to the tortures they are put through in order to make them entirely change their nature, and bear any amount of brutal treatment. I cannot think how men and women can bear to see a woman put her head into the mouth of a lion or tiger; and to watch poor animals being teased and beaten until they are nearly driven mad. We learnt from a sad case that was tried in Leeds last year, how inhumanly animals are tortured before they can be made to bear all I have described, and to jump through rings which are all blazing with fire. The animals who were made to do this last horrid feat were hyænas belonging to 'Edmonds' travelling menagerie.' Surely these performances are almost as disgraceful to the spectators as to the performers. Sad to say, little children are often taken to see these dreadful sights.

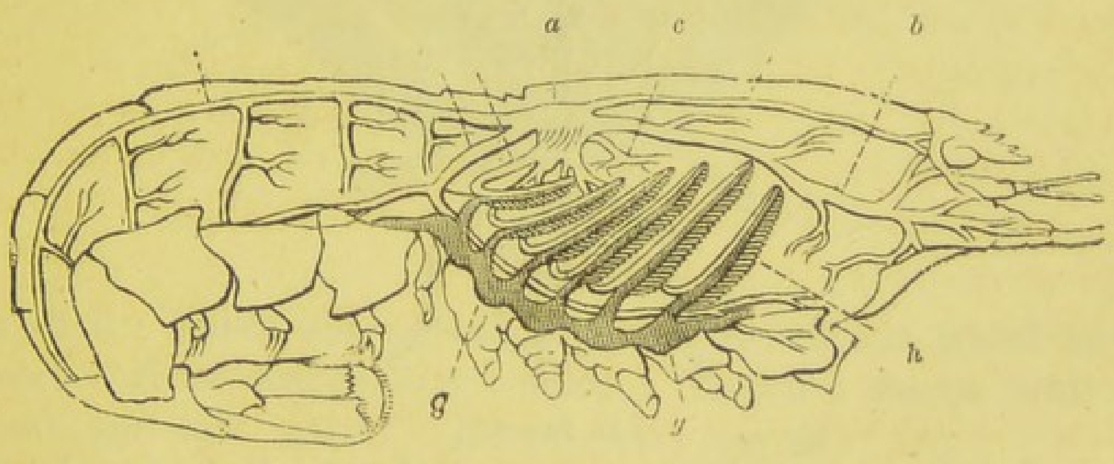
Bird-catchers have many cruel practices; amongst others, they sometimes put out the eyes of birds in order to make them sing, and keep hundreds of them packed together in tiny cages just big enough to hold them. Birds are accustomed to find shade in the woods during the hot part of the day; instead of that you find them placed in cages which are hung in windows where the blazing sun shines upon them for hours, and they are to be seen panting for air. Pigeon-shooting is a most cruel sport. This sport used to be carried on until last year in the Leeds Royal Park, and is still carried on in grand places near London. Pigeons are the most domestic and affectionate of all birds. People, when speaking of a gentle person, often say she is as gentle as a dove (a dove is the common wild pigeon). At a pigeon match men stand at a certain distance from little boxes, in each of which a pigeon is put. When the men who are going to shoot have got their guns pointed ready, the boxes are opened, so that the pigeons can fly away. Very often they are too tame, and will not move. In order to make them fly the feathers are plucked from the breast, so that the pain they will then suffer may make them fly. Pins are stuck into them for the same purpose. On September 22, 1874, my brother-in-law, Mr. George Buckton, saw the following case: 'On the 22nd ult., about five o'clock in the afternoon, Mr. George Buckton, North Hill, was in his garden near the gates of Roundhay Park, when he heard an explosion, and looking around he saw a pigeon flying over the garden, and noticed flashes of light proceeding from its tail, and simultaneously accompanied by a loud crack. It then struck him that fireworks were attached to the bird's tail, and looking over the garden wall he saw the two defendants, Elijah Walls and John Hunt. He and his gardener followed them, and the defendants were apprehended at the gates of Roundhay Park. In a box which they carried were found two pigeons with crackers tied to their tails. The two defendants, who were boys, stated that the other defendants, Walls and Heaton, had asked them to let off the pigeons at five minutes' intervals. Inspector Peet was communicated with, and found all the defendants together. The elder defendants expressed sorrow for what they had done, and were each fined *5s.* and costs. The younger defendants were dismissed with a caution.'

A lady friend of mine who lives close to the Royal Park, after hearing a constant firing for two or three hours, put on her bonnet and went out to get away from this unpleasant noise, as she knew that at every shot a poor little pigeon was either being killed or injured. She met a man coming out of the park, and asked him how many pigeons had been shot; he thought about 300. 'What is done with them all?' she said. 'I'll show you,' he replied; and putting his hand into his pocket he pulled out two pigeons which were half alive; his pockets were full, and no doubt the rest were in the same state. No *man* can call this sport; it is only cruelty and butchery.

Rabbit-hunting is equally a very cruel and unmanly amusement. Rabbits are naturally very timid creatures. They are kept in a dark place until the minute they are wanted, and then let loose into a small space, with dogs ready to fly after them. The light so dazzles them that they are caught directly, and torn to pieces.

Birds are of the greatest use to man. They eat insects and the eggs and grubs of insects which injure our fruit trees, kill our crops of wheat, barley, and oats, the vine, and other plants. In an exhibition in the garden of the Tuileries in

FIG. 38.




Invertebrate. *a* is the heart, *h* the lungs or gills, *b* and *c* arteries.

Paris I saw last summer a large collection of stuffed birds in glass cases, with a bit of the tree that they kept healthy fastened round their necks. The insects and eggs that they killed were also shown.

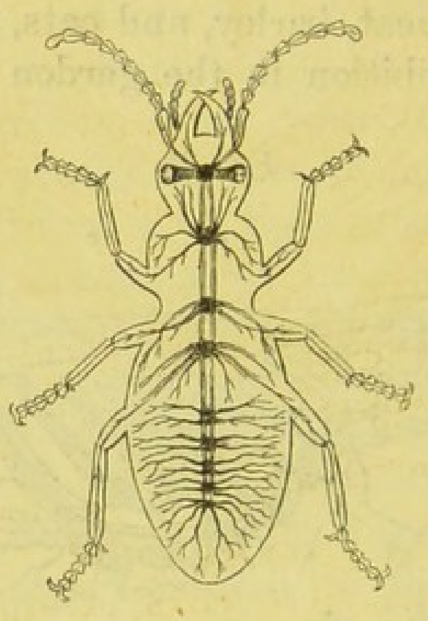
Sea-gulls are birds that live in the holes of rocks by the sea. They often save ships from being shipwrecked because sailors can hear their screams when the fog is too thick for them to see even the light from a lighthouse. A few years ago it was the custom to shoot great numbers of these birds to trim ladies' hats with; but so many shipwrecks occurred, that a law was made to forbid their being killed at certain times.

So far I have only told you about animals which have a backbone and a bony skull, called vertebrate animals. I am now going to tell you a little about the four types of animals that have neither a backbone nor a bony skull, called Invertebrate. Here are pictures of them, represented by a lobster, an oyster, a starfish, and an amœba.

First there is the lobster; you see it has neither a backbone nor a bony skull. It has a great many legs that are all jointed.

A bee has the same kind of body and legs. All insects—such as the bee, butterfly, cockchafer, grasshopper,

FIG. 39.



An Insect.

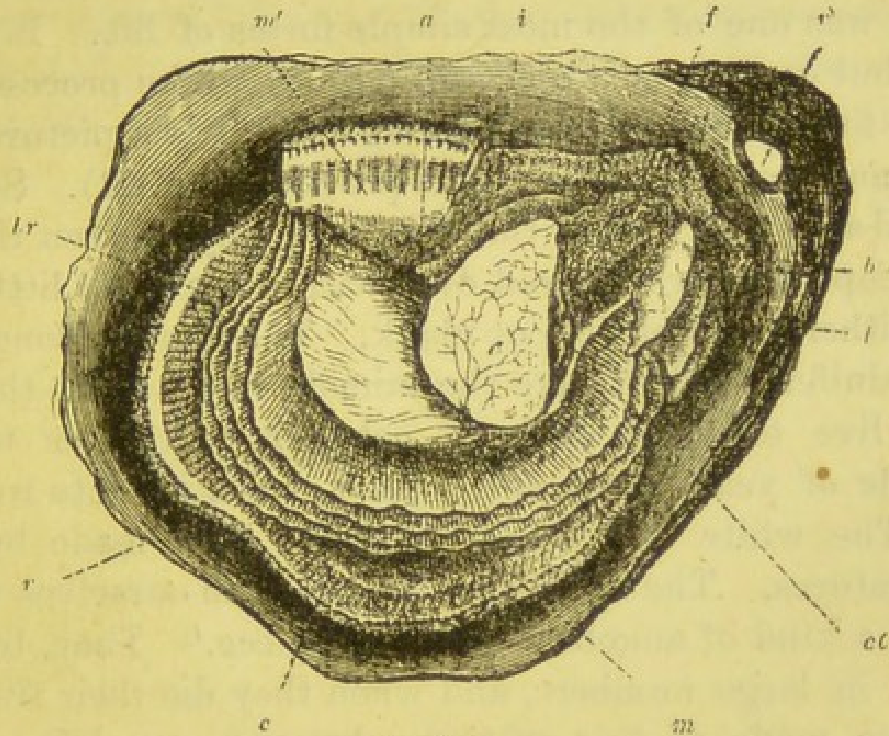
or flea—are made in the same way, and are called jointed animals, as they have a number of joints. We owe a great deal to insects. For instance, there is the honey we get from bees. All poor people who live in the country ought to keep bee-hives. In an answer which I received from one of you it was said that only animals which have a backbone and a bony skull had nerves and could feel pain. This picture (fig. 39) will show you that even an insect has nerves which spread all over its body, so that it must be capable of feeling pain.

Here is the picture of an oyster, which represents the second type of animals without a backbone and a bony skull. They have soft bodies, nerves, and several organs.

Their bodies are commonly covered with shells that are either divided into two parts, like those of an oyster and a cockle, or with shells that are all in one, like a periwinkle.

I shall now say something to you about the wonderful little animals that belong to the two lowest types. You see this picture of a creature that looks like a star. It is called a

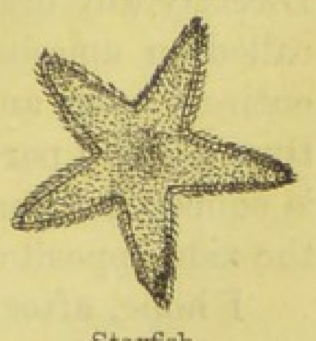
FIG. 40.



An Oyster.

starfish. There are a great many different kinds, which have most curious shapes and colours. They are found both in fresh and salt water. If you ever go to Blackpool you can see plenty of them. Besides the starfish there are other kinds of very small animals, called zoophytes. Creatures of this type have only one organ, a stomach, placed in the centre. Sometimes there are little holes or rooms all round this stomach. The walls of these little rooms are made of a stony substance by the little jelly-fish. Sometimes these creatures live together in great numbers, and form themselves into most curious and beautiful shapes, like the branches of trees. When you go with me to the Museum I will show you a beautiful collection of glass representations of

FIG. 41.



Starfish.

them. Their stems are made of coral or lime, or of some horny matter. There are large coral islands in the Pacific Ocean that have been made during tens of thousands of years by these little animals. The red coral beads that are made into necklaces are made by another kind of jelly-fish or zoophyte.

One of the lowest types of life is the amœba—our old friend that I showed you at my second lecture, and which I told you was one of the most simple forms of life. It has no organs, but can put out an arm-like or a leg-like process when it wants to seize food or move along. Here is a picture of an amœba putting out its limb-like process (fig. 42). Some of this kind are so very small that they can only be seen through a microscope, and are covered over with a beautiful little shell that is either made of lime or chalk. They have a long name —Foraminifera. They, like the animals which make the coral islands, live together in large colonies, and after tens of thousands of years their shells have grown up into rocks or cliffs. The white cliffs of Dover have been made by these little creatures. The sponge we use to wash ourselves with is made by a kind of amœba. Here is a piece.[1] They, too, live together in large numbers, and when they die their frames— which are made of this spongy substance—are left. These holes in the sponge are the places the animals live in. There are a great many different kinds of sponges, which you will see on Tuesday. Even the amœba must have some sort of feeling, as is shown by the way in which it catches its prey. Directly any organic substance touches it, the mass of jelly called an amœba spreads itself over the object, and covers it entirely over, and so takes it into its inside. After a little time a small part of the food that the amœba could not digest is squeezed through the jelly, and comes out perhaps through the side opposite to the one it entered.

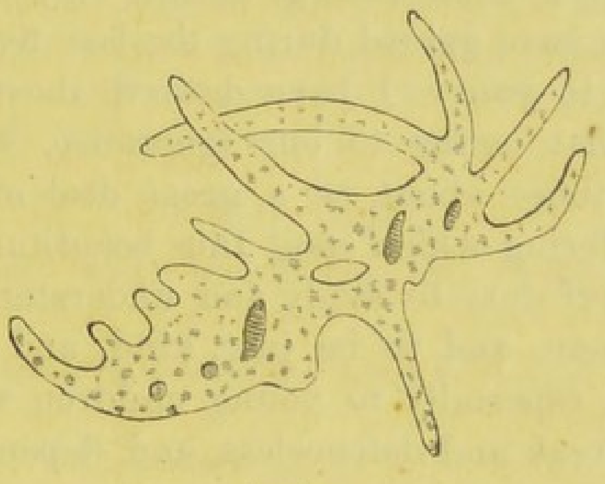
I hope, after all I have told you, you will be able to write answers to the questions which I shall give you at the end of this lecture. I am anxious to tell you on what part of its body an animal ought to be struck when it is necessary that it should be slaughtered. No animal can live when its neck

[1] I showed a large piece of sponge.

is broken. The limbs sometimes move, but the animal is quite unconscious.

Ignorant people will always be superstitious—that is, believe any silly thing that they hear. A gentleman not long ago saw a crowd of people on Hounslow Heath collected round a snake which two men were beating. He asked them why they did not kill the poor creature at once. 'We are snake-killers,' they said, 'and know all about it; it would be no use to try and kill a snake before the sun goes down.' 'Give me the stick,' said the gentleman, 'and I will show you that the sun has nothing to do with it.' With this he hit the snake

FIG. 42.



Amœba.

a hard blow on the back of its neck, just where the head joins the spine. The body of the snake continued to wriggle about; and though the gentleman knew that the animal could no longer feel, and would soon cease to move, still, to satisfy the crowd, he struck the snake all down the spine; after doing this it was still, and they were satisfied that it was dead.

It is dreadful to think of the cruelty that goes on in slaughter-houses. Some butchers think it is unnecessary to give food and drink to animals who are going to be killed in a day or two, or to keep them in clean stables. We pay very dearly for this cruelty, because the meat of animals so treated is not good. Ignorance and cruelty are very extravagant things. I do not wonder people become vegetarians when they know all that animals have to endure from long journeys and brutal drovers, before they are slaughtered by ignorant and cruel butchers, or their lads.

You must read all the books you can find on natural history. I have written down the names of some, which your masters and mistresses will lend you. When your parents have a holiday, I hope they will often take you to the Museum, for then you will be able to tell them all you know about the collection of animals you will see there. I am very sorry to say good-bye to you, for you have all been so polite and attentive that I have looked forward with great pleasure to seeing you every week. In a few years you will all be gaining your livelihood in different ways—as labourers and artisans, teachers, nurses, cooks, grooms, butchers, and emigrants; and some of you may become rich men, and become masters yourselves. Whatever your calling in life may be, I hope the information you have gained during the last five months may prove valuable to you. I have desired above all things to prove to you that, owing to our ignorance, we bring upon ourselves and those about us a great deal of the sickness, sorrow, and suffering which spoil this beautiful world. It is therefore our first duty to study and understand the laws of God, to obey them, and to be just, kind, and humane to all He has created, especially to young children and dumb animals, who are weak and defenceless, and depend upon us for protection and care.

# APPENDICES.

## APPENDIX I.

The contents of this Appendix were printed in the form of a little tract, a copy of which was given to every scholar who attended my lectures. My hearers were thus enabled to recall some of the facts on which I had laid special stress.

The information here given will be found in an expanded form in the lectures which treat of food and cooking; but the tract is reprinted in the hope that it may suggest to any ladies who may undertake the same work a simple method of communicating important knowledge. I may add that the tract was gratefully received, and those who were not present eagerly sent to ask me for copies.

### FOOD TABLE.

A human body which weighs 154 lbs., or 11 stones, ought to have about—

111 lbs. of water—90 lbs. of this water is oxygen, the rest is hydrogen.
12 lbs. of fat (body-warmer).
24½ lbs. of albumen and fibrin (flesh-formers).
5¾ lbs. of phosphate of lime.
¾ lb. of soda, potash, and magnesia ashes.

Oxygen is the chief means by which the food we eat is changed into at least 40 different substances to nourish our different organs. When we are in health the active parts of these organs ought to be completely changed in about 40 days. When oxygen meets with carbon in any one of the 40 substances mentioned, and combines with it in the body, heat is formed. Oxygen purifies the blood.

| BODY-WARMERS | | FLESH-FORMERS | |
|---|---|---|---|
| Animal | Vegetable | Animal | Vegetable |
| Butter | Sugar | Meat | Flour |
| Dripping | Treacle | Fish | Oatmeal |
| Suet | Starch, in Bread and all Vegetables | Poultry | Rice |
| Oil | Oil | Game | Peas |
| Lard | | Eggs | Barley, &c. |
| | | Cheese | |

The following salts and many others are found in the blood; therefore food must be eaten that contains them:—

| | | |
|---|---|---|
| Common Salt | Carbonate of Potash | Salts of Magnesia |
| Carbonate of Soda | " Lime | Phosphate of Iron |
| | Phosphate of Lime. | |

Bread contains a great deal of this latter salt.

Potash prevents scurvy. It is in all fresh vegetables, most in potatoes; in all fruit, most in lemons.

New milk is a body-warmer and a flesh-former, and contains everything the body requires. Digests in two hours.

There are contained in one pint of—

| | *Cow's Milk.* | *Mother's Milk.* |
|---|---|---|
| Water . . . . . . . | 13 oz. | 14 oz. |
| Flesh-former . . . . . . | $\frac{3}{4}$ " | less. |
| Body-warmer . . . . . . | $1\frac{1}{4}$ " | more. |
| Phosphate of Lime, Potash, and other Salts . . . . . . | $\frac{1}{2}$ " | same. |

The two principal vegetable flesh-formers are bread and oatmeal.

Time to digest.
Hours.

$3\frac{1}{2}$ 2 lbs. of bread cost *5d.*, and contain 3 oz. flesh-former, 1 lb. $4\frac{1}{2}$ oz. body-warmer, $\frac{1}{3}$ oz. ashes, 8 oz. water.

$3\frac{1}{2}$ 2 lbs. of oatmeal cost 6*d.*, and contain 4 oz. flesh-former, 24 oz. body-warmer, $\frac{1}{2}$ oz. ashes, 3 oz. water (uncooked).

The principal animal flesh-formers are beef, mutton, and rich cheese.

Time to digest.
Hours.

$3\frac{1}{2}$ 2 lbs. of beef or mutton cost 1*s.* 10*d.*, and contain 7 oz. of flesh-former, $4\frac{1}{2}$ oz. of body-warmer, $\frac{1}{4}$ oz. ashes, 20 oz. water.

Component parts of rich Cheddar cheese, in 2 lbs.—flesh-former, $9\frac{1}{2}$ oz.; fat, $9\frac{3}{4}$ oz.; ashes, $1\frac{1}{2}$ oz.; water, $\frac{1}{2}$ oz.

Flour, oatmeal, ground rice, ground peas—1 lb. of any one of these vegetable flesh-formers will give a man as much strength as 3 lbs. of lean beef, or 3 lbs. of veal, or 3 lbs. of ham boiled, or nine bottles of Bass's pale ale, or six bottles of Guinness's stout, 10*d.* per bottle. There is also as much nourishment in 1 lb. of double Gloucester cheese as there is in the above quantities of animal food and drink.

A full-grown man requires daily 10 oz. of body-warmers and 5 oz. of flesh-formers. Water and ashes are not included in these quantities. These 15 oz. of solid food can be got either from animal or vegetable food. But some vegetables contain a smaller proportion of solid matter, because they have so much more water; we must therefore eat more of them. They digest more slowly than meat. When we eat dry food, such as bread, oatmeal, &c., we require to take some liquid, as tea or milk. Masters, when they shut up dumb animals and feed them on dry food, such as linseed, rapeseed, lentils, &c., ought to give them a larger quantity of water than they have in the fields.

The following list will show how much water there is in animal and vegetable foods:—

(Sixteen ounces make one pound.)

| Hours to Digest | One Pound of | Price per lb | Contains of | | | |
|---|---|---|---|---|---|---|
| | | | Body-warmers | Flesh-formers | Water | Ashes |
| 3½ | Bread . . . | 2½d. | about 10 oz. | about 2 oz. | about 4 oz. | about ⅙ oz. |
| 4 | Meat . . . | 11d. | ,, 3 ,, | ,, 3 ,, | ,, 10 ,, | ,, ¼ ,, |
| 3½ | Cheese . . . | 11d. | ,, 4½ ,, | ,, 5½ ,, | ,, 5½ ,, | ,, ½ ,, |
| 2 | Milk . . . | | ,, 1½ ,, | ,, ½ ,, | ,, 14 ,, | |
| 3 | Eggs . . . | | ,, 1½ ,, | ,, 2½ ,, | ,, 12 ,, | |
| | Butter . . | | ,, 14 ,, | None | ,, 2 ,, | |
| | Suet . . . | | ,, 14 ,, | A trace | ,, 2 ,, | |
| | Dripping . . | | ,, 14 ,, | None | ,, 2 ,, | |
| | Oils . . . . | | ,, 14 ,, | ,, | ,, 2 ,, | |
| | Lard . . . | | ,, 14 ,, | ,, | ,, 2 ,, | |
| | Loaf Sugar . | | ,, 14 ,, | ,, | ,, 2 ,, | |
| | Arrowroot . | | ,, 14 ,, | ,, | ,, 2 ,, | |

## DRY FOODS.

(Grains, Seeds, &c.)

Wheat — Rice
Oats — Semolina (costs 8d. per lb.)
Peas — Macaroni ,, 8d. ,,

In one pound of these there are about

1½ oz. of water.
12 oz. fat-formers.
2 to 3 oz. flesh-formers.
¼ oz. salts and minerals.

*Chiefly given to feed Dumb Animals.*

Linseed — Grass
Rapeseed — Lentils
Clover.

The last is the most nutritious of all grains. It is ground, and sold under the name of Revalenta Arabica. Unground, it is very good put into soups.

## WET FOODS.

(All Green Vegetables and Fruits.)

| | |
|---|---|
| Potatoes | Rhubarb |
| Turnips | Apples |
| Carrots | Oranges |
| Onions | Gooseberries |
| Lettuce and all kinds of Salad | Currants, &c. |
| | Lemons. |

In one pound there are about

12 oz. to 14 oz. of water.
2 oz. fat-formers.
1 oz. flesh-formers.
$\frac{1}{2}$ oz. salts and minerals.

Macaroni and semolina are most nourishing foods. They are both chiefly made from that part of wheat which makes flesh, muscle, and bone. A tablespoonful of semolina will thicken a pint of milk: it makes a delicious pudding. One ounce of macaroni will make a good pudding when boiled in milk. When boiled in water, it is very good with cheese, grated or scraped fine over the top, and browned either before the fire or in the oven, with pepper and salt. Rice and macaroni can be eaten with meat, gravy, or with sweets, such as treacle, sugar, &c. Cook them exactly as you would cook a potato or any fresh vegetable; put them into boiling water, and let them simmer until quite tender. Don't *boil* any kind of food. Simmering takes a longer time to make the food tender, but when it is done all the good things will have been kept in it. Never wash macaroni. Corn-flour, like arrowroot, is very poor food, particularly for children, as it makes very little bone and muscle, and only makes fat.

The stomach digests a variety of food better than only one kind. Nature intended us to mix foods together; that is the reason we eat—

| *Vegetable Food.* | | *Animal Food.* |
|---|---|---|
| Bread . . . | with . . . | Cheese |
| Bread . . . | „ . . . | Butter |
| Bread . . . | „ . . . | Milk |
| Potatoes . . . | „ . . . | Meat |

There is very little fat in fowls, therefore we eat bacon with them. There is very little fat in veal, therefore we eat ham with it. Salt meat has had the juices and ashes taken out by the salt, therefore we must eat cabbages and bacon, or potatoes and bacon together.

People eat a great deal of animal fat in cold countries, because they want heat. There is more oxygen in cold air than in hot air to attack the carbon. In hot countries vegetable fats are more used. There is much more Hydrogen and Oxygen in vegetable than in animal fats, and therefore they are more easily digested. Fruit contains a great deal of sugar and water. We perspire more in hot countries and hot weather, so require more water.

A child's digestion is more delicate than that of a grown-up person; therefore children like vegetable fat-formers, such as sugar or treacle, better than animal fat, and they are better for them. Sugar also helps to dissolve the ashes that make bone, and purifies the blood.

Hot food is more digestible than cold.

A great quantity of hot liquids taken daily, particularly of tea, is bad for the process of digestion, and tends greatly to weaken the power of the stomach.

In one pound of either tea, coffee, cocoa or chocolate (which are both the same thing, as they come from the same berry), are to be found the following substances:—

Tea.

| | OZ. | GRAINS. | | OZ. | GRAINS. |
|---|---|---|---|---|---|
| Water | 0 | 350 | Sugar | 0 | 211 |
| Theine | 0 | 210 | Fat | 0 | 280 |
| Caseine | 2 | 175 | Tannic acid | 4 | 87 |
| Aromatic oil | 0 | 52 | Woody fibre | 3 | 87 |
| Gum | 2 | 385 | Mineral matter | 0 | 350 |

Coffee.

| | OZ. | GRAINS. | | OZ. | GRAINS. |
|---|---|---|---|---|---|
| Water | 1 | 407 | Caffeic acid (with potash) | 0 | 280 |
| Sugar | 1 | 17 | Gum | 1 | 192 |
| Fat | 1 | 402 | Woody fibre | 5 | 262 |
| Caseine | 2 | 35 | Saline matter | 1 | 31 |
| Caffeine, or theine | 6 | 122 | | | |
| Aromatic oil | 0 | 1½ | | | |

Cocoa, or Chocolate.

| | OZ. | GRAINS. | | OZ. | GRAINS. |
|---|---|---|---|---|---|
| Water | 0 | 350 | Starch | 1 | 53 |
| Albumen or gluten | 3 | 85 | Woody fibre | 0 | 280 |
| Theobromine | 1 | 140 | Colouring matter | 0 | 140 |
| Cocoa-butter | 8 | 0 | Mineral matter | 0 | 280 |
| Gum | 0 | 426 | | | |

## FOODS MOST SUITABLE FOR HEALTH.

### *Our Body-Warmers*

Are butter, dripping, suet, any kind of oil or fat, and also sugar and starch.

If you lived on these alone, you would be pined.

### *Our Flesh-Formers*

Are bread, oatmeal, and all kinds of flour, eggs, cheese, and meat.

If you lived entirely on these foods, you would have scurvy and skin diseases.

Oatmeal requires to be very well cooked. Cooks as a rule do not give it a sufficient time. Porridge is best made of the coarsely-ground Scotch oatmeal.—Mix two tablespoonfuls of it with a small tea-cup of cold water till it is all one thickness, then pour a pint of boiling water, and keep stirring it frequently for forty minutes over a fire or on a hot hob ; it is then fit to eat, but will be much more digestible if it is kept simmering for a much longer time. Should the porridge become too thick a little water can be added. It should be served in a hot soup-plate and milk added. This is the most nourishing food a man or child can eat. In some parts of Scotland the people eat a preparation of oatmeal called brose or stirabout. Boiling water is poured upon the oatmeal, which is well stirred, and then eaten without any more cooking. This is a most indigestible food, and causes a complaint called pyrosis.

### *Potash will prevent our having Scurvy.*

The potash bought at a druggist's shop won't serve. You must eat food in which it is contained. All green vegetables have a little ; also ripe fruit, oranges and lemons particularly. Potatoes and all floury vegetables are nearly all starch ; therefore, let the water be boiling when you put them in the pan, then the skin hardens directly, and all the potash is kept in. Dried grains, such as split peas, &c., must be soaked in cold water (rice in milk) for several hours.

### *Lime and Phosphorus.*

These two substances, which form the hard part of our bones, are to be found in the largest quantities in bread and oatmeal. No doctor or druggist can give you these mixed as nature mixes them in these two kinds of food.

An infant cannot digest bread until it has cut its teeth.

### *Milk*

Is the only one food that contains all the forty things that can nourish the body. It is the only safe food for an infant until it is a year old. Every child ought to take a great deal of it daily, in puddings, with porridge at breakfast, and at tea-time, until it is eight years old, or it will be in danger of having rickets or soft bones, for the bones are not hard under that age. An infant fed on cream, which is fat, would be pined; for it is only a body-warmer. Skimmed milk is also a flesh-former. New milk is both a body-warmer and a flesh-former. New milk from a cow or goat is the only proper food for an infant until it is about eight months old, when it cannot have its mother's milk. The milk must be warmed, and a little water added should it prove too rich for the stomach.

### *Nourishing Soup for Children and Working-Men.*

Soup is good food for old and young; first, because it is a warm dish, and secondly, because it can be made to contain the three kinds of food we must eat to nourish our bodies, viz., body-warmers, flesh-formers, and minerals. An immense number of soups can be made of animal and vegetable food without butcher's meat. Dripping, bacon, milk, or eggs will do as well, as they are all animal foods. The first of the following receipts will make a good soup for children and working-men; it is made with butcher's meat. The second is also most nourishing; it has no butcher's meat.

First Receipt.—Some meat (beef is best) should be cut into pieces and stewed for two hours. Then add to the meat and broth flour of any kind to thicken it, and put as much milk as you can. Let it stew for an hour, and flavour with salt.

Second Receipt. (Soup without butcher's meat.)—1 quart of water; ½ gill of green peas or split peas (the latter take much longer to cook); two potatoes, old ones of yesterday are the best; 1 onion; 1 head of lettuce; 1 sprig of mint; ½ teaspoonful of sugar (sugar keeps the colour of the peas and vegetables); 1 oz. of dripping; 1 table-spoonful of either flour or oatmeal; pepper and salt to taste. When it has simmered until all is quite tender, add ½ gill of milk. If this soup is made with green peas or any fresh vegetables, it will be quite ready in half-an-hour.

Soyer, the celebrated cook, almost always used brown sugar and a little vinegar in making his soup. Soup is a most economical food, and digestible if bread is eaten with it.

When we make soup or beef-tea, we want to get all the juices and ashes out in the water; therefore cut the meat up into small pieces, and put a little salt on it, and let it stand in cold water one hour or more. Don't let it quite boil, only simmer, for the steam carries off the flavours and juices. An equal weight of meat and water makes very strong beef-tea. A person fed on the strongest beef-tea, or on any kind of extracts or essence of meat, would soon be pined to death; they only form flesh. Flour, rice, pearl barley, cream, eggs, or new milk ought to be added.

When we roast meat we want to keep in all its juices, therefore we must harden the outside skin by placing the joint near a hot fire for the first ten minutes, then it ought to be roasted very gradually by removing it to a much greater distance, as meat quickly cooked is never good. When meat is baked, there ought to be a ventilator in the oven to let out the steam.

To keep the juices in boiled meat, place it in boiling water for ten minutes, and then cook it very gradually.

If meat cannot be got, cheese is as nourishing for people who work hard or take much exercise, and, if well masticated, is not difficult to digest, as some people think it is.

*Table of the Constituents of the Juices of Flesh.*

| | | |
|---|---|---|
| Albumen | Butyric acid | More potash than soda |
| Caseine | Common salt | Osmazome, flavouring matter |
| Sarcine | Red colouring matter | |
| Lactic acid | Salts | |

*The Patent Norwegian Self-acting Cooking Apparatus.*

The following are the directions for the use of the Patent Norwegian Self-acting Cooking Apparatus:—Put the joint of meat, or other viands intended to be cooked, with the boiling water or other fluid, as the case may be, into the saucepan of the Apparatus, and place it on the fire. Allow the boiling to continue for a quarter to half an hour, taking care that the lid of the saucepan is firmly down; then take the saucepan off the fire and put it, without opening it, into the Apparatus. Cover it carefully with the cushion, and fasten the lid of the case firmly down. In this state the cooking will complete itself in rather longer time than the ordinary mode takes, say from 3 to 6 hours *according to the meat* to be cooked.

The time required for boiling must not be reckoned from the moment the liquid begins to simmer, but from the time strong jets of steam are seen escaping from underneath the lid.

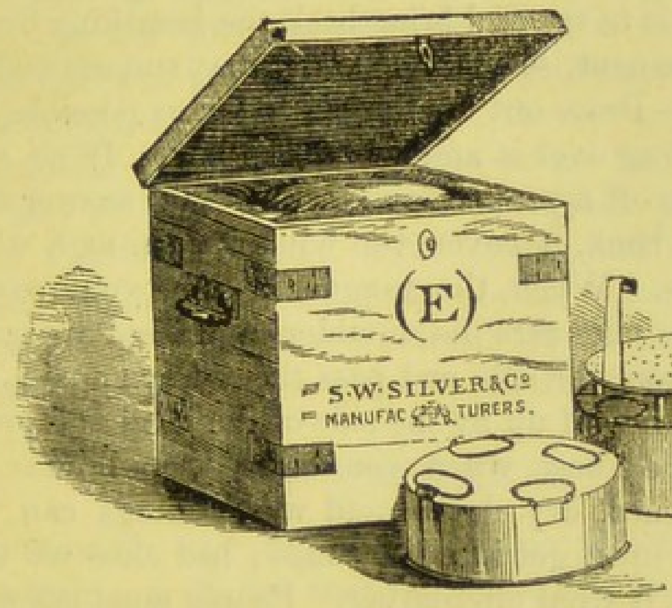
Care must be taken not to squeeze too large a piece of meat into a small saucepan, thereby leaving too little space for the necessary cold water, and not to use a large saucepan for a small quantity of food. The saucepan should never be less than two-thirds filled either with food or water.

If an Apparatus with two saucepans be used, it may at any time be opened while cooking is going on in one pan, to add another with boiled-up water or food, but the box must not be left open for more than a minute or two.

If required to cook in one saucepan only, and the apparatus holds two or more, fill the saucepans not in use with boiling water.

The bottom of the saucepan should be greased before being put on the fire, and wiped with a cloth previously to being placed in the Apparatus.

N.B.—The food must be cooked in the pans belonging to the Apparatus, and when used for boiling, the water is not to be poured away when the pan is taken off the fire.




When it is desired to keep meat or other food, which has been previously cooked, hot, use one of the saucepans fitted with a jacket, which should be filled with boiling water, and the dry chamber of the Apparatus used for the hot meat. Any kind of viands may be kept hot for hours in this manner, and when eaten will be found quite as palatable as if only just cut from the joint.

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## HOW TO DRESS A SCALD OR BURN.

Everybody should know how to manage a scald or a burn. Doctors say that the most distressing cases that are brought to an infirmary are those caused by scalds and burns, because the parents have not understood how to treat them. I once called at a house where a little girl had burnt her arm. The mother showed me the place, and tore off the linen rag, saying, 'It ought to be better, for I wash it regular twice a day.'

The air must be kept out instantly, as the germs that fly in the air will settle in the raw surface. Cover the place all over with a piece of linen rag that has been dipped in any sweet oil, or melted fat that has no *salt* in it; then wrap it up with a good deal of cotton wool, or a piece of old blanket; don't remove these for seven days, as a new skin will form in that time, and then dress again in the same way. If the skin is not broken and there is no blister, you may put on cold bandages or place the limb in cold water, and so keep out the air. The great thing is to keep out the air and not to break the skin. If the scald or burn is a bad one, send immediately for a doctor.

## HOW TO TREAT A PERSON APPARENTLY DROWNED.

*The first thing* is to try and bring back the breathing by turning the face down for a moment, so that the water may run out and the tongue fall into its place. Draw out the tongue as far as possible, and keep it out by tying a string over it and round the jaw. If no string is at hand, a piece torn off a pocket-handkerchief will answer the purpose. If the tongue falls back, it covers the windpipe through which the air passes to the lungs. When the tongue is safe, you may place the person on his back; take care the shoulders and head are raised a little. Lift the arms up from the side and pass them down again, to open the chest, drawing them well up by the side of the head and pressing them forcibly against the chest when you bring them down. When the breathing has returned, dry clothes and warm things can be put on. Plenty of fresh air must get into the lungs; bad close air thickens the blood and prevents it from circulating. People must not crowd round the patient. It is dangerous to use great heat suddenly, such as a hot bath. Rubbing and warmth should be continued for two hours at least.

## DIRECTIONS FOR BATHING.

If people are strong enough, a cold bath should be taken every day when the weather is warm. When the cold water touches the surface of the body the shock drives the blood to the heart, and makes the heart beat quicker, and send the warm blood back to the surface of the body. I told you that there were an immense number of blood-vessels and nerves in the second skin; the warm, fresh blood flushes and stimulates these, and this is why we feel a glow all over the body after a bath, and are stronger and fresher. If a cold wet sponge or towel is rubbed all over the body, and then the skin is made perfectly dry by using a rough, dry towel, the same good will be done as if the person had taken a cold bath. It is very unhealthy to allow the body to remain the *least damp*. Before a person takes a regular bath he must be careful not to enter the water directly after a meal, because the organs of digestion are then busy, and want all the warm blood to help them to do their work. That is why the surface of the body feels cold after dinner. It is dangerous to enter the sea or any bath when the person is cold and tired. About two hours after a meal is a good time, and when a short walk has increased the heat of the body. Mr. Wheelhouse tells me that there is a popular belief that it is bad to enter the water when the body is warm or perspiring, but in truth there is no harm in doing this. The real danger arises from waiting until the glow has passed, and entering the water when the body has already begun to cool. Very much depends on the length of time that is spent in the water. To some persons three minutes is sufficient time, and if they can swim, ten minutes may be taken. When the body is warm and all in a glow on coming out of the water, you may be sure that the bath has done no harm, but good. On the other hand, those who feel cold and shivering after a cold bath are advised to take tepid baths in preference. Little children are often forced into the water in a state of great terror. If those who have the care of them are sensible and patient, they can make them enjoy their bath: and unless they do enjoy it, they will be injured instead of benefited, for fear, as I have told you, chills them, and weakens instead of strengthening the nerves. A friend of mine, who is now an elderly lady, was bathed by her father when she was five years old, and from that time to this she has been afflicted with a difficulty in speaking.

## DISINFECTANTS.

Next to fresh air, the best and cheapest disinfectant is permanganate of potash. A packet that makes twenty gallons can be bought for a shilling of any druggist. A teaspoonful is to be mixed with two gallons of water. You can wash the body with it safely, as well as furniture, clothes, and floors.

The air in a bedroom where there is fever is full of poisonous germs. Open the window at the top, or break a hole in the top pane of glass. This will let in the fresh air. A pound of fresh air contains about a quarter of a pound of oxygen; and the oxygen will burn up the poisonous matters in the air.

After a fever or any infectious complaint, all articles of bedding can be purified free of any expense. If a post-card be sent to the Inspector of Nuisances, whose salary is paid out of the rates, he will immediately send for the above articles and place them in the hot-air apparatus, which will kill all germs of disease.

# APPENDIX II.

## BOOKS.

As I am often asked by ladies to mention the books which I found useful in the preparation of my lectures, I append a list of those which proved most valuable to me. The list does not profess to be complete, but it may serve to suggest sources of information to others who are desirous of working in the same field.

'Animal Physiology,' by Dr. W. B. Carpenter.
'Physiology of Common Life,' by G. H. Lewes.
'Elementary Physiology,' by T. H. Huxley.
'Physiology for Practical Use,' edited by James Hinton.
'Philosophy of Health,' by Dr. Southwood Smith.
'Heat Considered as a Mode of Motion,' by Prof. Tyndall.
'A Handy Book on Health,' by C. A. Cameron, M.D.
'Public Health,' by Dr. Guy.
'Health,' by Dr. E. Smith.
'Practical Dietary for Families, &c.,' by Dr. E. Smith.
'Foods,' by Dr. E. Smith.
'Food,' by Dr. Lankester.
'Food,' by Dr. Letheby.
'Air and Rain,' by Dr. Angus Smith.
'The Chemistry of Common Life,' by Prof. Johnston.
'How Crops Grow,' by S. W. Johnson.
'Management of Infancy,' by Andrew Combe.
'Every-Day Wonders,' by Anne Bullar.
'Notes on Nursing,' by Florence Nightingale.
'Dust and Disease,' by Prof. Tyndall.
'Yeast,' a Lecture, by Prof. Huxley.
'French Home Life.'
'Illustrated Horse Doctor,' by Mayhew.
'Horse Management,' by Mayhew.
'Shoeing,' by G. Fleming.
'Healthy Skin,' by Erasmus Wilson, F.R.S.

I used Mr. Marshall's diagrams; they are the best, and large enough for any lecture-room. The small edition of these diagrams and a key are necessary for private study. The best plan is to order the small edition first, from Smith, Elder, & Co., 15 Waterloo Place, London, and then select the large diagrams that will best illustrate the lectures.

The following beautiful models by Auzoux, which Leeds, strange to say, does not possess, were lent to me from Keighley by Mr. Swire

Smith, one of the Honorary Secretaries of the admirable Mechanics' Institute of that town:—

Heart of Adult, 50 francs.
Ear (not the largest size), 100 francs.
Half the Eye, 75 francs.
Horse's Foot, 50 francs.

They must be ordered direct from the maker. Address—Au Docteur Auzoux, Rue Antoine-Dubois, Paris.

Very good anatomical casts are also prepared by Messrs. Ramme & Stodmann, Hamburg. English agents, B. W. Hedley & Co., 76 Mount Pleasant, Liverpool.

The following are those I have used. The catalogue contains a great many more of different sizes:—

| | £ | s. | d. |
|---|---|---|---|
| No. 10. Organ of Hearing, to be opened | 1 | 2 | 6 |
| No. 19. The Heart, to be opened | 1 | 2 | 6 |
| No. 21. Contents of Chest, natural size | 2 | 10 | 0 |
| No. 26. Contents of Abdomen, natural size, and entirely divisible | 4 | 0 | 0 |
| No. 32. Foot, with Ligaments | 0 | 11 | 0 |

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'The Ladies' Council of the Yorkshire Board of Education' are most anxious to render any assistance to ladies who are desirous of giving Sanitary Lectures.

To them is due the initiation of these lectures. Mrs. Baily, Mrs. Fenwick, myself, and our late talented townswoman, Mrs. James Kitson, were invited three years ago by this body to give some sanitary lectures to the working-women of Leeds. The Council find rooms, issue notices, provide diagrams, and do all that is possible to relieve ladies of any unnecessary trouble. The two pamphlets written respectively by Mrs. J. Kitson and myself were published by them. Their office is at 9 Tower Buildings, Leeds. Any application directed to the general Honorary Secretary (Mrs. Francis Lupton) will be immediately attended to. It is to be hoped that every town and village will soon possess a similar organisation.

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## APPENDIX III.

### QUESTIONS ON CRUELTY TO ANIMALS.

The following questions were set at the close of my lectures, and prizes were offered for the best answers, by the Society for the Prevention of Cruelty to Animals.

1. How have a great number of cattle been killed and injured in vessels that have brought them from foreign lands? Why do animals that are carried from place to place in dirty railway carriages or trucks become diseased?
2. Why do you think dumb animals require as much pure fresh air as human beings? Name some of the complaints they suffer from when they have been shut up in dirty stables.
3. Why do you think it is not only very cruel but very silly of men who drive cattle, and who want them to go faster, to strike them on the head?
4. Where would you strike an animal if you wanted to kill it as quickly as possible?
5. Describe the horse's hoof, and tell some of the mistakes which ignorant men make when they shoe a horse. Do you think a horse ought to have water in its stable, so that it can drink whenever it is thirsty? Would you beat a horse if it shied at any object it felt afraid of? What would you do to make horses or any animals less timid and nervous?
6. Describe the reason why horses which are driven with a bearing-rein become what are called 'roarers.' What harm is done by bad drivers who keep constantly jerking the reins, and pulling up the horse's head?
7. Why do you think that a dog might be driven mad if it had a muzzle on its mouth that would prevent it from drinking water and from putting out its tongue?
8. Why is it cruel not to give water to sheep, rabbits, parrots, and all animals on long journeys, or when they are shut up and not allowed to find their own food in the fields or woods?
9. Why is it a very cruel and foolish practice to cut the ears of any kind of dog?
10. Which of the vertebrate animals do you think have the most courage, sense, affection, understand best what is said to them, and never forsake an old friend? Tell any stories you can remember about dumb animals.
11. Why do you consider that pigeon-shooting and rabbit-hunting, which used to be done in the Leeds Royal Park, and are still done in grand places near London, ought not to be called sport, but butchery and cruelty?
12. Give some of the reasons why it is selfish to make pets of birds and wild animals.
13. Why are travelling menageries, in which wild animals are trained to perform unnatural tricks, cruel places, which ought not to be allowed?
14. Why do we suppose that even one of the lowest animals, called the amœba, has some sort of feeling?

# INDEX.