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Pirie, George A.

Publication/Creation

Dundee : Kidd, 1902.

Persistent URL

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Notes on Health

AND

Temperance.

SECOND EDITION.

BY

GEORGE A. PIRIE, M.A., M.D.

DUNDEE:
WILLIAM KIDD, WHITEHALL STREET.
1902.


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NOTES

ON

HEALTH AND TEMPERANCE.

SECOND EDITION.

BY

GEORGE A. PIRIE, M.A., M.D.,

(Formerly Lecturer on Health and Temperance in Dundee Board Schools).

DUNDEE:

WILLIAM KIDD, PALACE BUILDINGS, WHITEHALL STREET.

1902.

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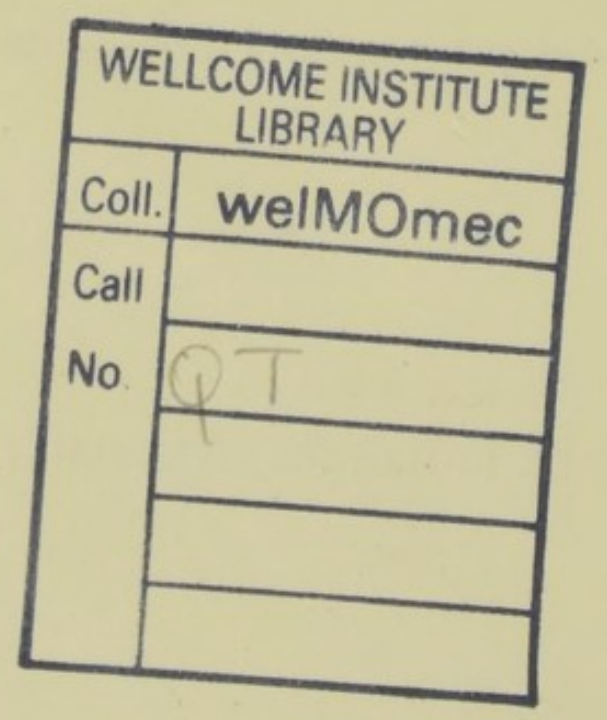
"I am inclined to doubt whether the study of health is sufficiently impressed on the minds of those entering life.

"If all are agreed as to the blessing of health, there are many who will not take the little trouble or submit to the slight sacrifices necessary to maintain it.

"Many, indeed, deliberately ruin their own health and incur the certainty of an early grave or an old age of suffering."

—Lord Avebury.



PREFACE TO SECOND EDITION.

During the past seven years there has been a great extension of temperance teaching in schools; and the first edition of this little book has been exhausted. The author has taken the opportunity to bring the book up to date and render it more serviceable by the addition of quotations, questions, and an index. He had the privilege of introducing temperance teaching into the schools of Arbroath by six lectures, delivered in November 1900; and the experience then gained is incorporated here. It is hoped that the notes may prove of service in placing the main facts of health and temperance clearly before the scholar.

Obedience is the secret of life. Obedience to the laws of Nature is the secret of health. If these laws are broken (consciously or not) the result is disorder, and it may be disease. Hence the necessity that every scholar should know the laws of health, and the equal need of self-control to obey them. The former may be learned in school; the latter must be acquired and developed throughout life.

Let me quote the words of one who was deeply versed in the whole subject, and strove by his writings to guide his fellow-men to health and happiness.

"May we not receive it as a sure principle that when men are once convinced that a certain course will bring them a material good, they will eventually pursue that course; and if once the principles of health can become implanted and taught to each generation the tendency to follow the guidance of those principles will grow.

"So much physiology being learnt, the reason of the rules of health, the necessity of breathing pure air, the use of exercise, &c., would be clear; and at last all would learn to treat their bodies with the respect and care which is essential."—*The late* PROF. PARKES, *of Netley.*

PREFACE TO FIRST EDITION.

These notes have been prepared by request, and are based on the Health Lectures delivered by the author in 1892 and 1893 to scholars in the Dundee Board Schools.

The chief rules of Hygiene are stated, and sufficient reference is made to Physiology to explain why inattention to those rules is apt to be followed by loss of health. Special reference is made to the composition of alcoholic drinks, and their injurious action on the body.

It is hoped that these notes will be found of service by indicating the points of chief importance and containing in small compass most of the information required.

DUNDEE,
August, 1895.

CONTENTS

NOTES ON HEALTH.

CHAPTER I.

FOOD AND DIGESTION.

Varieties of Food—Effects of Cooking—the Course of Digestion—and Absorption. Errors in the Choice of Food—in the Preparation of it—in the Mode of Eating it. Some Practical Rules.

Introductory. Food, air, and water are required by a man if he is to remain alive. Without *air* he would die in a few minutes: without *water*, in a few days: and without *food*, in a few weeks.

But the food needs to be *well-selected*—in order to furnish a complete supply of nourishment: *well-cooked* so as to be easily digested and absorbed: and *carefully eaten*, so that digestion may not be hindered.

Digestion begins in the *mouth*, where starch is changed into sugar: continues in the *stomach*, where albuminous foods are rendered soluble: and is completed in the *intestines*, where fat is changed into a milky condition. And so all the nourishment in the food is ready to be absorbed into the blood and carried by the circulation to every part of the body.

FOOD supplies the energy and warmth which the body requires, as well as the material for growth and repair: but it must be

(1) Well-selected,
(2) Well-prepared for eating,
(3) Thoroughly digested.

Only then is the nourishment in the food capable of being absorbed and made use of.

Choice of Food. Articles of food are arranged in five classes according to the chief element present in each—albumen, fat, starch, salt, or water. A day's diet ought to contain all these elements.

(1) Among albuminous foods are beef, fish, white of egg, peas, &c.
(2) Among fatty foods are beef-fat, bacon, butter, oil, &c.
(3) Among starchy foods are bread, potatoes, rice, sugar, &c.
(4) Salts are contained in various vegetables and fruits. Common salt is the chief member of this class.
(5) Water is present in all foods.

Some articles of diet (*e.g.* milk) contain all these elements, and are sufficient by themselves to nourish the body. Others require to be supplemented in order to furnish a perfect diet, which should contain twice as much starch as albumen, and twice as much albumen as fat. Thus the following would be a sufficient day's diet for a man:—Bread, one pound; meat, half a pound; fat, quarter of a pound, with a little salt and about four pints of water.

Both the animal and vegetable kingdoms supply man with albuminous and fatty food, but starchy food is derived from the vegetable kingdom only. Hence it is possible to maintain life on a purely vegetable diet (*e.g.* by using peas instead of beef, and cocoa instead of fat). The cost of such a diet is less, but the nourishment in it is not so readily digested. It requires more careful cooking and mastication. On the other hand, animal food satisfies longer and has a greater stimulating effect on the system,

e.g. A bear fed on bread is gentle—fed on beef it becomes ferocious. "For man a mixed diet is found to favour the best physical development and the highest intellectual vigour."

Preparation of Food. It is not sufficient that the food should contain the proper kinds of nourishment. That nourishment must be easily obtainable from it. In other words the food must be palatable and digestible. This change is effected by *cooking* which softens the food and improves its flavour. A few articles of diet may be eaten uncooked (*e.g.* milk and fruit); but for others cooking is essential, otherwise the albumen would be digested with difficulty and the starch not at all.

The albumen in meat is enclosed in a fibrous sheath which resists the action of the digestive fluids for a long time. The grains of starch in vegetables are enclosed within a cellulose wall which is absolutely indigestible by man. Now, cooking softens the fibrous sheath by transforming it into gelatine; and it bursts the cellulose case and the starch grains. It thus permits of the digestive fluids reaching the nourishment inside.

Digestion of Food. After the food has been well chosen and well cooked, it only remains to have the nourishment changed into a liquid form. This is done in the course of digestion, which begins in the mouth, is continued in the stomach, and completed in the intestines.

(1.) In the mouth the food is broken down by the teeth and mixed with saliva, which flows from several glands under the tongue and in the cheeks. The saliva softens the food, and thus prepares it for being swallowed: it also acts on the starch present, which it gradually changes into sugar. This is the first stage of digestion.

(2.) On being swallowed, the food passes down the gullet into the stomach—an oval bag lying nearly in the centre of the body. Here it remains for a few hours and undergoes further changes As soon as the stomach receives the food, a quantity of fluid

(gastric juice) begins to trickle from innumerable small pits in its wall, and soon afterwards the wall itself begins to contract and relax. Thus the food is kept constantly moving about and is thoroughly mixed with the gastric juice, which gradually dissolves the albumen present. This is the second stage of digestion.

(3). The food now resembles gruel in consistence, and is allowed to pass out in small quantities into the intestine—a tube about 25 feet long lying in the belly. Here it is at once mixed with two other fluids (bile from the liver and pancreatic juice), which enter the intestine together through a small opening near its upper end. The intestine presses the food on by waves of contraction, and constantly adds a juice of its own (intestinal juice), which keeps the contents liquid. But the bile and pancreatic juice have a powerful effect on the food. Together, they reduce the fat to a milky condition, and dissolve any starch or albumen which may have passed unchanged through the mouth and stomach. This forms the third stage of digestion.

In this way most of the nourishment in the food is changed into a liquid form, and can be absorbed through the wall of the stomach and bowels, and thus enter the blood stream, which carries it all through the body.

The Digestive Juices. In *saliva* the active digestive agent is ptyalin, which can change starch into sugar; in *gastric juice* — pepsin and hydrochloric acid, which can change albumen into peptone; in *pancreatic juice* —trypsin and carbonate of soda, which can digest both starch and albumen but whose special work is to digest the fat. *Bile* contains no digestive agent, but merely emulsifies the fat, and so assists the pancreatic juice to digest it. *Intestinal Juice* contains invertin, which has a slight action on cane-sugar; but its chief use is to keep the contents of the intestine liquid until all the nourishment has been absorbed.

Absorption. In the wall of the stomach and intestine, there is a network of fine blood-vessels (capillaries), which become very full of blood while digestion is proceeding. From them is withdrawn the fluid which forms the digestive juice, and into them is put the fluid containing the digested nourishment. This double flow (secretion and absorption) continues

till digestion is complete. Thus all the nourishment in the food is transferred from the stomach and intestine into the blood circulating in the body; and from the blood thus enriched each tissue can take the particular kind of nutriment it needs.

Errors in Diet. The natural method of supplying nourishment to the body having been described, it will be well now to point out some common errors in the selection and preparation of food, and to refer to certain rules which have been found useful in regulating the daily meals.

(1) **Errors in the Choice of Food.** Some people live on bread only. This contains sufficient starchy matter, but little albumen, and scarcely any fat. Others live on potatoes, which consist almost entirely of starch. In either case there is a *deficiency of albumen*, and as a result the bodily strength is not maintained; or so much food has to be eaten that it disorders the stomach. The remedy is to take, along with the bread, some cheese at one meal, and some butter or bacon-fat at another. Thus sufficient nourishment of the right kind is obtained, and health is preserved.

If *no fat* is taken in the day's diet, a larger quantity of meat is required, and it is not so easily digested. Besides, the absence of fat weakens the body and renders it liable to consumption and scrofulous diseases.

If *no starchy food* can be obtained (as on the American Prairies), very large quantities of meat have to be taken, and the stomach is apt to be overloaded.

If there is *a deficiency of salts* in the food (as on a long voyage), the sailors are liable to suffer from scurvy. Fresh vegetables and fruits are needed to prevent this.

A perfect diet need not be expensive. "Dr Parkes kept a strong soldier doing hard work in perfect health on $1\frac{3}{4}$ lb. of oatmeal and 2 pints of milk daily, at a cost of ninepence."

Food is most nourishing in a fresh state ; but preserved food is useful when taken occasionally to complete a day's diet. If preserved by freezing (*e.g.* frozen meat), or by boiling (*e.g.* tinned meat), or by drying, (*e.g.* dried fruit), the food is still very nutritious ; but salting removes half the nourishment and leaves the meat hard and indigestible (*e.g.* salt beef and smoked fish). Salted and dried meat cannot be used long without impairing the health.

All kinds of food are liable to undergo decomposition, or decay if left exposed to a warm, moist atmosphere. The change can usually be detected by the presence of a disagreeable smell. Such food is unfit for eating (*e.g.* tainted meat, putrid fish, rotten fruit).

This change is due to the growth of microscopic plants in the food. They change the nourishment into substances that are often irritating and sometimes poisonous to man. Thorough cooking may kill the plants, but does not always destroy the poison they have produced. Hence such food is still dangerous, and if eaten after insufficient cooking it is very apt indeed to cause great irritation of the stomach and bowels, and thus bring on a form of cholera.

(2) **Errors in the preparation of Food.** All food should be perfectly *clean*, and kept till needed in a perfectly clean place. This applies specially to fruit and other articles of diet that are eaten uncooked.

If milk is stored near a house where a person is suffering from fever, it is liable to become charged with the germs of disease. A safe plan is to boil the milk ; in this way any cause of infection in it is destroyed.

Water drawn from a shallow well, or conducted in imperfect pipes, is liable to contamination from the surrounding soil. If stored in a cistern that is seldom cleaned, it is apt to become polluted by matter falling into it. Pure water has neither colour, taste, nor smell. If the water is of doubtful purity, it should be boiled and filtered through charcoal.

Food should be properly *cooked*. A raw egg is more slowly digested than a lightly boiled one, but a hard-boiled egg takes longer time than either. Vegetables require more thorough cooking than animal food. Underdone meat may be digested, but a hard potato will lie in the stomach like a stone and cause severe indigestion.

(3) **Errors in the Eating of Food**. All food should be eaten slowly: it should be carefully chewed and thoroughly mixed with saliva before being swallowed.

If *bolted in lumps* the food lies long in the stomach, for the gastric juice is unable to penetrate it, and indigestion is sure to follow.

If *eaten hurriedly* the food is not properly mixed with saliva; hence most of the starch in it is passed on undigested to the intestine, which has thus extra work thrown upon it. Besides, too much food is apt to be taken; the stomach becomes overloaded and unable to perform its work properly: hence also drowsiness and dullness during the day, followed by sleeplessness at night.

If the interval between two meals is very long there is a danger of extreme fatigue before the second meal, with indigestion after it, for the stomach already weakened by fasting is called upon to digest a larger quantity of food than usual. There should be four meals daily, with an interval of about four hours between them: (*e.g.* breakfast at 9 A.M., dinner at 1 P.M., tea at 5 P.M., supper at 9 P.M.)

The reason for observing this rule is that food takes on an average about four hours to be completely digested in the stomach, which is thus ready for a fresh supply after that interval. The exact time needed for the digestion of various articles of diet has been noted from observations on patients with an opening in the stomach left by gun accident (*e.g.*, the case of Alex. St. Martin, reported by Dr. Beaumont). Thus boiled rice is digested in 1 hour; boiled beans takes 2½ hours; apple dumpling 3 hours; boiled potatoes 3½; and boiled cabbage 4 hours. Among animal substances tripe is completely digested in 1 hour, and trout in 1½ hours; boiled beef takes 2¾; cheese 3½; while roast pork takes 5¼ hours.

Practical Rules. The *first meal* of the day should be taken soon after rising, and before any work is done—for the body has then little reserve material, and, if much exertion is needed, it is undertaken at the expense of the tissues.

The *last meal* of the day should be a light one, and is best taken an hour before bedtime. If a heavy supper is taken, either the stomach continues working and keeps the body awake, or a deep sleep comes on which stops digestion, and is apt to be followed by sickness in the morning.

A *hearty meal* should neither be immediately preceded nor followed by active exercise; for thorough digestion requires a vigorous stomach. Hard work just before a meal leaves the stomach fatigued; and just after a meal the stomach needs all its energy for its own work.

The *amount of food* required by the body may safely be regulated by the appetite, if the diet be simple and eaten slowly. After hard work and in cold weather more food is required.

The *amount of water* needed, in addition to what is contained in the food, is best regulated by the feeling of thirst. Only a small quantity should be swallowed at a time. Pure water is the best quencher of thirst. Tea, coffee, and cocoa are refreshing beverages.

Tea is an exhilarating and refreshing drink; it relieves the feeling of fatigue, and removes drowsiness. This action is due to the presence of an active principle (theine). Tea, if infused only a few minutes, contains a little astringent matter (tannin) and a volatile oil which gives it a pleasant aroma. If long infused, the tea loses its aroma and acquires a harsh taste from the increased amount of tannin, which also impedes digestion. Hence the error of allowing tea to infuse a long time.

Coffee is an invigorating drink, and it relieves both hunger and fatigue. This action is due to a similar active principle (caffeine). But coffee is also a food, for one tenth of it consists of fat. It also contains a little tannin and a volatile oil, which gives it a special aroma.

Cocoa is a very nourishing drink. One tenth of it is starch, one fifth is albumen, while as much as one half is fat. In this form it is too rich; but if some of the fat is removed, or if a simple infusion is made of the cocoa nibs, it is then palatable and digestible.

Alcoholic drinks differ entirely in their source and composition, also in their action on the body. They require more careful study, and will be considered in the next chapter.

QUESTIONS:

1. What four purposes are served by food?
2. What are the five classes of foods?
3. Compare animal and vegetable foods?
4. What change does cooking effect?
5. What is the purpose of digestion?
6. Explain how the food is altered in the mouth, the stomach, and the intestines.
7. Give examples of errors in the choice of food.
8. Why is it a mistake to eat fast?
9. Compare tea, coffee, and cocoa as refreshing drinks, and as foods.

CHAPTER II.

ALCOHOLIC LIQUORS.

The Manufacture of Wine—of Beer—of Spirits—their composition—the action of Alcohol on the Mouth—on the Stomach—on the Liver.

Introductory. Beer, wine, and spirits are called *alcoholic* liquors, because they differ from all other beverages by containing a liquid called alcohol.

If some wine be put into a glass vessel and boiled, a strongly-smelling substance passes off in the form of vapour; but if the vapour be conducted through a tube, kept cold by a stream of cold water, it turns into a liquid again and drops out at the end of the tube. By repeating this process several times, the liquid is obtained pure, and is then called *spirit of wine* or *alcohol.* It is clear like water but not so heavy, and if touched by a lighted match it burns with a pale blue flame; also, if a little be placed on the tongue it causes a sharp burning sensation; (hence savages call it fire-water).

Alcoholic Liquors are made from fruits or juices. which contain starch or sugar. *Beer* is made from barley; *Wine* from grapes; other liquors from potatoes, sugar-cane juice, &c. *Spirits* may be obtained from any of these liquors by distillation.

But in all these drinks the intoxicating element is alcohol. On an average Beer contains 5°/₀ of alcohol; Wine 20°/₀; and Spirits 50°/₀. Their effect on the stomach depends on the degree of

concentration (*i.e.*, the percentage of alcohol in the liquor); their effect on the nervous system varies with the total amount of alcohol swallowed.

Alcoholic Drinks are made from various kinds of fruit and grain by a process of fermentation, which changes their sugar or starch into alcohol. They are divided into three principal classes according to their mode of manufacture (wine, beer, spirits).

(1) **Wine.** Ripe grapes contain much sugar (10—30°/₀) together with a small quantity of acid. When burst and exposed to the atmosphere they begin to ferment; the sugar disappears gradually while alcohol takes its place, and much carbonic acid gas is given off causing a froth on the surface. At first the process is very brisk, and keeps all the contents of the vat in commotion; but after a few days the action comes to an end. The solid matter settles as a sediment, and leaves a clear fluid which is drawn off and stored as wine. Wine contains about 20 °/₀ of alcohol.

The varieties of wine depend partly on the kind of grape used and its degree of ripeness, and partly on the process of manufacture.

Some grapes have a special aroma; unripe grapes contain more acid and less sugar; grape-skins vary in colour and contain tannic acid.

If the grape-skins are left to ferment with the juice, their colour and acid pass into the wine. The longer fermentation is allowed to go on, the more alcohol and the less sugar will there be in the wine. After fermentation is over, the liquor contains 14 °/₀ of alcohol, but some wines are "fortified," or increased in strength by the addition of pure spirits to keep them from turning sour (*e.g.*, Port and Sherry). They may thus contain as much as 36 °/₀ of alcohol.

(2) **Beer.** Barley contains much starch, but no sugar. It is therefore moistened and spread on a floor, where it begins to sprout. At the end of ten days, most of the starch has been changed into sugar, then the growth is stopped by drying the

grain slowly upon a kiln. The malt thus produced, is crushed and hot water is poured over it. After a few hours the water is drawn off; it contains all the sugar from the barley and is called 'wort.' This is next boiled with hops, for their astringent matter is found to be of use in preserving it. If now filtered and left exposed to the air, the wort would slowly begin to ferment; but to hasten the process, yeast is thrown in. After a few hours a froth commences to form on the surface (the sugar is being changed into alcohol and carbonic acid), and in three or four days the fermentation comes to an end. The scum is removed, the suspended matter settles to the bottom, and the liquid is drawn off and stored as beer. On an average, beer contains about 5 °/₀ of alcohol.

Several varieties of beer are prepared. The lighter kinds (ale) are made from pale malt—that is, malt dried at a low temperature. The darker kinds (porter) are obtained from malt that has been roasted. Sometimes burnt sugar is added to deepen the colour. The degree of bitterness in beer is due to the quantity of hops used in its preparation.

(3) **Spirits** are obtained from fermented liquors by distillation, and contain on an average 50 °/₀ of alcohol. There are four chief kinds manufactured.

Brandy is usually distilled from wine, but much is also made from fermented potatoes, and the resulting spirit is flavoured to resemble true brandy. Freshly prepared brandy is colourless, but when kept in an oak cask it turns pale yellow. Sometimes burnt sugar is added to colour it more deeply. Brandy contains from 53 to 54 °/₀ of alcohol.

Rum is distilled from fermented molasses, and contains 48½°/₀ of alcohol. (Molasses is the name given to a thick kind of treacle obtained from the juice of the sugar-cane in the preparation of solid sugar). When a mixture of molasses, skimmings from the sugar boilers and water, is exposed to the air it rapidly ferments, and the liquid obtained by distilling this is called rum.

Whisky is prepared from fermented grain, and contains from 45 to 46 °/₀ of alcohol. The barley is malted in the usual way and then dried over a peat fire. The peculiar odour of the peat smoke adheres to the grain, passes into the liquid during fermentation, and distills over with the spirit.

Gin is also prepared from fermented grain. It contains from 38 to 39 °/₀ of alcohol. The grain is not usually malted, but is allowed to ferment in its natural state. The product is then distilled twice over, and flavoured with juniper berries and various aromatic substances.

Thus all the alcoholic drinks consist principally of water and alcohol (from 5 to 50 °/₀). Beer contains in addition some sugar; wine has both sugar and acids in varying amounts, with a trace of ether and volatile oil; spirits contain several ethers. But in each case the intoxicating effect is produced by the alcohol which they contain.

QUOTATIONS:

"Persons in good health do not require any alcoholic drinks. Children are best brought up without them."—*Sir Samuel Wilks.*

"There is no doubt that healthy and young people are better without alcohol."—*Dr. Rolleston.*

"The constant use of alcohol, even in moderation, is deleterious to health."—*Sir William Gull.*

"Alcohol is for healthy people a very inconvenient form of food. Young and healthy people do not require it, and are better without it."—*Sir Lauder Brunton.*

"Alcohol is not at all required in health."—*Sir J. Burdon-Sanderson.*

Alcohol and the Stomach. Pure alcohol cannot be swallowed. Even with a little water added, it would burn the mouth and the gullet owing to its power of rapidly abstracting

water from the tissues. If not well-diluted before being swallowed, it draws water from the blood through the wall of the stomach until sufficiently weak, and then it is absorbed. When introduced into the stomach it irritates that organ and brings about an increased flow of gastric juice; hence it gives rise to the belief that alcohol assists digestion; but it has several bad effects:—

(1) The gastric juice though artificially increased in quantity becomes poorer in quality after a time, and the glands producing it are weakened by being habitually overworked. Hence they gradually fail to respond to the natural stimulus of the food swallowed, and then the presence of an alcoholic stimulant is felt to be a necessity.

(2) The food is altered, for strong alcohol tends to harden meat, eggs, &c., and renders them more difficult to digest.

(3) If strong spirit is taken during a meal it acts directly on the gastric juice, diminishing instead of increasing its digestive power. [This is due to the alcohol precipitating the pepsin in the gastric juice, and so putting a stop to its activity. Hence, if a quantity of spirits has been swallowed with a meal, the food may be thrown up some hours—or even days—later in an undigested state.]

(4) The discomfort produced by indigestion may be relieved by a dose of strong spirits, but the digestion is not thereby assisted; for the alcohol only deadens the nerves of the stomach, and causes the passage leading from the stomach to the intestine to open and make a way for the undigested food before the proper time. Thus extra work is thrown upon the bowels, which are very apt to be injured thereby.

(5) Alcohol irritates and inflames the delicate lining of the stomach, with its glands and blood-vessels, and thus reduces their digesting and absorbing power. In course of time the constant irritation causes the wall of the stomach to become thick and rigid, while the juice it secretes is small in quantity and has scarcely any digestive power. Such a stomach is of no use for digesting food.

Alcohol and the Liver. The effect of alcohol on the liver is not less serious than on the stomach. At first the liver is irritated and becomes swollen. If the habit of drinking strong spirits is continued, much of its substance turns fatty, and this interferes with the proper performance of its work. Later, fibrous bands are formed; the liver shrinks and becomes very hard, and in this state it is known as "*hob-nail*," or "*gin-drinker's liver*." As a consequence, the circulation of blood through the liver is obstructed and a form of dropsy is apt to come on, which is almost incurable.

This effect requires a short explanation. The digested food is carried by the blood from the stomach and intestine direct to the liver, and is spread all through it by branches of the portal vein—to be, as it were, filtered or freed from hurtful matters before entering the general circulation. Indeed, the liver may be compared to a sponge, and it contains within itself a quarter of the whole blood circulating in the body. Now, alcohol itself is not digested in the stomach; it is absorbed unchanged and carried to the liver, where it is slowly distributed through every part. It is thus brought into close contact with the delicate structure of the liver, which it gradually destroys. The first effect is irritation; subsequently fatty changes occur; then fibrous tissue forms through and through the liver, which is thus rendered useless itself and the cause of disease to other parts of the body.

QUOTATIONS:

"On the digestive organs the ill-effects of drink are only too well-known—want of appetite, a loathing for food, and sickness."—*Sir S. Wilks.*

"Nothing with such certainty impairs the appetite and the digestive power as the continued use of strong alcoholic liquids."—*Dr. Pavy.*

"If the spirit be often taken, then the structure of the stomach becomes changed. It becomes inflamed and thickened, and incapable of producing a large enough quantity or a proper quality of gastric juice to digest food."—*Professor Fraser.*

"In excess, alcohol is doubly injurious at meal-times. By causing over-irritation of the mucous membrane, it diminishes the secretion of healthy gastric juice, and causes the secretion of mucus which, instead of aiding, interferes with digestion."—*Sir Lauder Brunton.*

QUESTIONS:

1. What is alcohol? What liquors contain it?
2. How is Wine made?
3. What is Beer made from? Describe the process?
4. What are the four varieties of Spirits? From what are they made?
5. How much alcohol do these liquors contain?
6. What effect has alcohol on the stomach?
7. How is the gastric juice altered by it?
8. How is the digestion of food affected?
9. What changes occur in the liver of a habitual drinker?

CHAPTER III.

AIR AND RESPIRATION.

AIR—its Composition—its use in the Body—the Lungs—Composition of Expired Air. Errors in Breathing—"Close" Air—Tainted Air—Dusty Air. Effect of Alcohol on the Lungs. Tobacco Smoking—its effect on the young.

Introductory. Air is an essential of life. It supplies oxygen and removes the carbonic acid and other waste gases. At every inspiration it is drawn through the windpipe into the lungs where the oxygen can readily enter the blood-stream, and the waste matter can be received from it. At every expiration it is expelled poorer and impure.

Pure air is essential to health. No mixture with dust, sewage gases, or exhausted air should be permitted in a room.

Alcohol injures the lungs directly. It also interferes indirectly with proper respiration, by chemically altering the blood and lessening its power to carry oxygen.

Air is a mixture of two gases: nearly one-fifth is oxygen, and four-fifths is nitrogen. There are also traces of carbonic acid and water vapour. The essential gas is oxygen; for, if deprived of it for a few minutes, a man would die. Nitrogen has no action of its own; it merely dilutes the oxygen. Carbonic acid is an injurious gas; the less of it in the air the better.

Oxygen is a colourless gas. It supports combustion: a glowing chip placed in it bursts into flame, and a lighted taper burns brilliantly. Oxygen also supports life: it can be breathed in a pure state with comfort.

Carbonic acid is a colourless gas. It does not support combustion: a lighted taper placed in it is at once extinguished. Neither does it support life: an animal placed in it is quickly suffocated.

Nitrogen is a colourless gas, but almost inert. It does not injure animals; but neither is it of service to them beyond diluting the oxygen.

Respiration. Some of the lower animals (*e.g.* frogs) can take in air through their skin: man has to draw it through his nose and windpipe into his lungs, where part of it is absorbed by the blood and carried through all the body.

The lungs are two elastic bags lying inside the chest; each lung is divided into a large number of small bags or pockets for the reception of air, and the wall of the chest acts like a bellows. Thus, when the chest is expanded, air is drawn into the lungs and fills those pockets (inspiration): after the effort is over, the chest resumes its previous shape, and so air is pressed out again (expiration).

The chest is formed by the twelve ribs on each side, and an arched muscle (diaphragm) below; it contains the heart and the two lungs. The enlargement of the chest is caused by the ribs being raised, and by the diaphragm being depressed. In ordinary inspiration both methods are used, but the former is more marked in women and the latter in men. When the chest expands, so do the lungs, for they are elastic and follow closely the movement of the chest wall. Air is drawn in and passes through the nostrils and down the windpipe. It enters the two larger branches, into which the windpipe divides, and the innumerable small ones which spread through each lung and conduct the air to the tiniest chambers there. Now, in the wall of these little cells there is a network of blood-vessels (capillaries). Thus the air is brought very close to the blood, which can readily purify itself by taking in a supply of oxygen, and putting out a quantity of carbonic acid. Then the air is expelled from the lungs by the pressure of the chest wall returning to its former position.

Change in the Air. The air expired differs from what was inspired; it contains 5 per cent. less oxygen and 4 per cent. more

carbonic acid, besides being warm and moist and having a peculiar smell. The reason is that much of the oxygen has been absorbed by the blood, and carried throughout the body to support the life of every part, while carbonic acid has been brought back instead, and got rid of along with other waste matters. This purification of the blood brings about a change in its colour; for the impure blood entering the lungs is deep purple, whereas the pure blood leaving them is bright scarlet.

The impure blood is sent from the right side of the heart, through the pulmonary artery into the lungs. Its purple colour is due to the deficiency of oxygen in it. It is laden with carbonic acid and other waste matters. While passing through the capillaries it rapidly absorbs oxygen, and its colour at once changes from purple to scarlet; at the same time it gets rid of much of its carbonic acid and passes out pure—into veins which convey it to the left side of the heart.

Errors in Breathing. (1) Air breathed out should not be breathed in again. This happens especially in crowded halls and in small bedrooms. The result is first a headache, then drowsiness, and if no fresh air is admitted it may lead on to serious illness, or even death; (*e.g.* the "Black Hole" of Calcutta, a room only 18 feet square, into which 146 persons were put at night and only 23 came out alive next morning). The air is laden with carbonic acid and waste matters discharged from the lungs at every expiration; and if the air is not changed these impurities accumulate, while the oxygen is gradually being used up. Hence the blood fails to purify itself properly, and the whole body becomes, as it were, poisoned. Consumption is frequently brought on by breathing such air night after night.

Fresh air contains only 2 per 10,000 of carbonic acid. If the air in a room contains 5 per 10,000 it is felt to be "close"; if it increases to 10 per 10,000 it is described as "foul"; and beyond that limit it becomes unbearable.

An easy test for the freshness of the air in a room is to take a clean bottle holding about half-a-pint; fill it with the air (by stuffing in a linen cloth and withdrawing it); then add a table-spoonful of lime-water and shake well.

If the liquid remains clear the air was pure; if it becomes milky, the air contained too much carbonic acid.

The extent to which air is rendered impure by breathing may be realised from this calculation. If 1000 people sit in a hall for one hour, they breathe out 4 gallons of water and as much carbonic acid as would come from a quarter of a hundredweight of burning coals—besides much waste matter that causes the close smell.

(2). Another mistake is to continue breathing air that is tainted with sewage gas from a defective drain, or with coal gas from a leaking pipe, or simply with the smell of dirt inside the house or refuse lying in the neighbourhood. Such air injures the health and is very apt to cause fever.

(3). Dusty air injures the lungs directly. Particles of coal and of steel do the most harm (*e.g.* to miners and needle-grinders); but common dust, if inspired constantly, is also injurious.

The remedy is to change the air of the room sufficiently often, so that injurious matters breathed out cannot accumulate. (Dirt in a house or near it should be cleared away; a faulty drain pipe should be put right at once). Every bedroom should be well aired during the day, and have the window open half-an-inch from the top at night. A man requires 3000 cubic feet of fresh air every hour. Therefore, if his bedroom be 10 feet square and 10 feet high, the air in it ought to be changed three times an hour during the night. A workroom shall be large enough to contain fresh air for all the workers, and allow of ventilation without perceptible draughts.

Regular exercise in the open air for two hours at least every day is the best plan for strengthening the lungs and maintaining the health.

Alcohol and the Lungs. Soon after a quantity of liquor has been swallowed, some of the alcohol may be detected in the breath; it is being got rid of by the lungs. If the habit of drinking is long continued, it brings on a form of consumption which is quite incurable.

Respiration is also seriously interfered with by the action of alcohol on the blood. The red corpuscles are weakened, and cannot take in so much oxygen: hence the blood is not so red in colour, and cannot supply the body properly. Hence also the shortness of breath on exertion.

The alcohol is absorbed from the stomach, passes in the blood-stream through the liver to the heart, from which it is sent to the lungs. There it has the effect of relaxing the blood-vessels, and some of it diffuses from the blood into the air and is expired along with other impurities. But the process has a weakening influence, and gradually the structure of the lung becomes affected; congestion leads on to inflammation and destruction.

Tobacco. The effect of smoking tobacco depends on the quantity smoked and the age of the smoker. "Excessive or even moderate smoking in a confined atmosphere is peculiarly injurious; it is especially so to young persons. Smoking to any extent is productive only of injury to the young."—(*Prof. Fraser*).

Tobacco is prepared from the leaves of an American plant (Nicotianum Tabacum). It contains a substance called Nicotin, which is so strong a poison that a small drop placed on the tongue of a dog will kill the animal almost immediately. Now, in smoking, some of the nicotin is drawn into the mouth and so gets into the system. A person unaccustomed to the use of tobacco has been killed by smoking two pipes; a habitual smoker has died after smoking seventeen continuously.

In a child the effects of tobacco are seen in the sickness, the sallow face, the dull expression, and the stunted growth which follow its habitual use. Both body and mind are injured by it.

Tobacco is used for smoking, chewing, or snuffing; in each case the active principle nicotin is absorbed from the mouth or nose into the blood-stream, and is capable of doing much harm to the body. (Nicotin is a liquid which may be separated by distilling the tobacco leaves).

For persons above 20 years of age smoking in moderation may not be productive of harm; but excessive smoking causes undoubted injury.

(1) Sickness and loss of appetite are due to its effect on the stomach.

(2) The heart's action is interfered with, and this brings on palpitation and giddiness (called smoker's heart).

(3) The throat is in a state of constant irritation (often called smoker's sore throat); while any exertion puts the smoker easily out of breath.

(4) The nervous system becomes injured; headache with sleeplessness is brought on, and eventually blindness if the smoking is not given up.

In a child even a small quantity of tobacco causes much injury. Digestion is quickly interfered with, hence the sickness. The blood is not properly formed and nourished, hence the paleness or sallowness of the face. The growth of the whole body is thus seriously checked. Some years ago, the scholars in France were forbidden to smoke tobacco for the reason "that the physical as well as the intellectual development of many youths has been checked by the immoderate use of tobacco."

QUOTATIONS:

Alcohol lessens the oxygen-carrying power of the blood, and thus interferes with the combustion which takes place in the various parts of the healthy body.—*Sir Lauder Brunton.*

The direct toxic action exerted by alcohol on the mucous membrane is probably the cause of the bronchial catarrh, which is not uncommon in drinkers.—*Dr. Rolleston.*

There is no form of consumption so fatal as that from alcohol.—*Sir B. W. Richardson.*

QUESTIONS:

1. What is air composed of?
2. What effect has each gas on the body?
3. How is the air drawn into the chest?
4. How is it expelled?
5. What changes take place inside the chest? (1) In the air. (2) In the blood.
6. Why is it unhealthy to breath expired air?
7. Give a test for impure air.
8. What other impurities may be found in air?
9. What effect has alcohol on the lungs?
10. Why is tobacco-smoking injurious to children?

CHAPTER IV.

THE BLOOD AND ITS CIRCULATION.

The Blood—its Composition—how it circulates. The Heart—its structure—its action. Blood-Vessels. How to have healthy Blood and a vigorous circulation. Effect of Alcohol on the Blood—on the Blood-vessels—and on the Heart.

Introductory. Blood is the means of Life. It carries the oxygen and nourishment to every part of the body, and brings back the waste matters. The heart acts like a pump to keep it moving: the blood-vessels guide it and regulates the supply to each part. It gets fresh nourishment from the stomach and liver; oxygen in the lungs, other substances of value from various glands. It gets rid of waste matter by the skin, the lungs, and the kidneys.

Rich pure blood, and an active circulation, are essential for the maintenance of health. A suitable diet, fresh air, and regular exercise are the chief means of attaining these ends.

Alcohol injures the blood, rendering it less rich and not so pure. It disturbs the circulation by reflexly exciting the heart, and relaxing the blood-vessels; later its direct action is seen in a weakened heart and diseased arteries.

Blood is a red fluid, thicker than water: it sets into a jelly soon after being shed. When examined under a microscope it is seen to consist of innumerable round particles floating in a clear liquid. Most of these bodies are reddish in colour and disc-shaped (Red Blood Corpuscles); they gradually stick together in rows like piles of coin. Mixed among them are a few colourless bodies (White Blood Corpuscles); they are globular and remain isolated. The liquid contains the food-supply for all parts of the human body; the red corpuscles carry the oxygen: the chief function of the white ones is to repair the tissues.

The colour of blood is due to a colouring matter (hæmoglobin) inside the red corpuscles. It takes up oxygen readily (*e.g.* in the lungs), and is then bright scarlet; it also loses oxygen readily (*e.g.* in the tissues), and becomes dark purple. Hence blood from an artery is scarlet, from a vein purple.

The red corpuscles are circular, about $\frac{1}{3200}$ inch across and flattened in the middle.

The white corpuscles are a little larger, and can change their shape by pushing out part of their substance and withdrawing it again; hence their power of squeezing through the wall of a blood-vessel and getting out to repair the tissues.

The liquid, in which these bodies float, is quite colourless. It is the carrier of nourishment to the tissues and of waste products (*e.g.*, CO_2) back again.

The clotting of blood is caused by fine threads (fibrin) forming all through it and entangling the red corpuscles. The clotting seals a wound and prevents further bleeding.

The Circulation. Blood in the body is constantly in motion. It is sent from the heart through one set of tubes (arteries) to every part of the body; and it returns through another set (veins) back to the heart. Thus the blood is always inside a system of tubes. From the heart it passes along a large artery (Aorta), which gives off branch after branch to supply the head, arms, &c., and it ends in branches to the legs. Each of these gives off smaller twigs, and so the blood is conducted to the smallest of all (capillaries), along which only one blood corpuscle can pass at a time. These capillaries are finer than the finest hair, but so

numerous that a needle pushed into the skin anywhere breaks several of them and so causes blood to escape. After passing slowly onwards, the blood enters a larger tube (vein) formed by the union of several capillaries. These veins again unite and become larger and larger, until they conduct the blood back to the heart.

But it enters the right side of the heart, whereas it had started from the left side. Now the heart is a muscular bag divided by a strong partition into two distinct chambers: so the impure blood returning from the veins into the right side cannot mix with the pure blood on the left side about to be sent off through the arteries. It has to pass through the lungs first and be purified there: and its course is from the right side of the heart through a large artery (Pulmonary Artery) and its branches to the capillaries in the lungs, from which it is collected by veins (Pulmonary Veins) and conducted to the left side of the heart.

Thus the blood has a double circuit to complete before it reaches the point whence it started. It the first circuit it passes from the heart through blood-vessels in various parts of the body and back again; in the second one, it passes from the heart through the lungs and back again.

The heart lies inside the chest, to the left of the middle line. It is a muscular bag completely divided by a vertical partition into two cavities (right and left), and each of these is partially sub-divided by a horizontal partition into two chambers (auricles and ventricles). Between auricle and ventricle is placed a valve, also between ventricle and artery. These four valves are formed of delicate membranes, and serve to guide the current of blood which the heart is driving on.

The Heart, by its regular action, keeps the blood constantly moving onwards. It beats about 70 times a minute, and, at each beat, it squeezes some blood into the arteries; then it relaxes and is filled with blood from the veins. During active exercise the heart beats more quickly and forcibly; during sleep it beats more slowly and gently: thus the blood circulates more rapidly at one

time, more leisurely at another. If an extra supply of blood is wanted by any part of the body (*e.g.* the stomach after a meal) the blood-vessels there relax and much blood passes through them.

The *heart* does not contract as a whole, but the auricles (filled with blood from the veins) act first and squeeze their blood into the ventricles, then the ventricles contract and send the blood into the large arteries. The valves open to let the blood through, then close and prevent it from returning.

The *arteries* are elastic tubes: they dilate on receiving the extra blood, and by their elastic recoil press it onwards. They are also muscular tubes; they relax and allow a full supply of blood to pass into any organ that requires it (*e.g.* a muscle in active exercise): afterwards, they gradually contract and allow a smaller quantity to flow through them.

The *veins* have little elasticity or muscular power, but they are provided with numerous valves which prevent the current of blood from going the wrong way.

In its circulation the blood serves many purposes. As it passes by the stomach and intestine it takes up much nourishing matter; as it flows through the lungs it takes in a supply of oxygen; in its course through various parts of the body it gives out nourishment and oxygen, and it takes up impurities which are disposed of later.

The blood is thus a carrier of both useful and useless materials. On its richness in nourishing matter depends the growth (and afterwards the maintenance) of all parts of the body—for each part takes from the blood the material it needs (*e.g.* bones get their lime from it; the brain derives its phosphorus from it; and so on). The useless matters taken up from the tissues come to be hurtful if not soon got rid of. The lungs, the skin, and the kidneys are most active in removing these. (See page 27).

Healthy Blood. The blood is of the utmost importance in carrying the means of life to every part of the body; but it must be properly supplied with nourishment, regularly relieved of waste materials, and it must be kept circulating well.

Thinness of blood (causing paleness of the face) is frequently produced by errors in diet (see page 13). It is more frequently brought on by breathing bad air (see page 27).

Weakness of circulation (causing blueness of the hands) is largely due to the want of sufficient daily exercise ; for the heart is a muscle and it participates with other muscles in the increase of size and vigour which follows daily well-regulated exercise ; for rules, see page 42).

The effect of breathing "close" or impure air is to lessen the number of red corpuscles in the blood, which is thus rendered paler and more watery—hence the blanched appearance of the skin. Breathlessness on exertion is also easily produced ; for the blood, thus impoverished, cannot carry sufficient oxygen to supply the needs of the body.

The effects of a sedentary occupation and no exercise is to weaken all the muscles and the heart too ; so that any sudden exertion is apt to cause a feeling of oppression in the chest with palpitation, due to the heart being called upon to do work which it is unable to perform.

In order to have rich blood and an active circulation, one must take nourishing food at regular intervals, and live in pure air as much as possible. He must also take daily exercise — short and easy to begin with, then longer and more vigorous as his strength improves.

Alcohol and the Blood. Soon after a quantity of alcoholic liquor has been swallowed, the alcohol is absorbed from the stomach into the blood, and passes in the circulation all through the body. It first affects the blood, then the blood-vessels and heart, and lastly, every organ to which it is carried.

(1) The *blood* is rendered less able to nourish the tissues ; it is also unable to carry so much oxygen as formerly, and thus remains of a darker colour. This is the reason that the face of a confirmed spirit-drinker is often seen of a dull red or even bluish colour. Besides, the blood clots very slowly when shed ; hence after an accident, much blood may be lost and the wound heals very badly.

"Alcohol forms a compound with the hœmoglobin of the *red blood corpuscles*, which takes up and parts with oxygen less readily than normal hœmoglobin." Further, if alcohol is constantly present in the blood, the corpuscles themselves become wrinkled and shrivelled up, and many of them are destroyed altogether.

The *white corpuscles* are hindered in their movements. This is partly the reason why wounds in a drunkard heal so badly.

The *liquid*, in which these bodies float, is also affected. For during health the nourishment in the blood is kept dissolved by water, and nothing will take the place of water for this purpose ; but the presence of alcohol hinders the solution, and thus the blood is impoverished.

(2) The *blood-vessels* too are affected by the alcohol. Its first action is to relax them, so that a large quantity of blood can pass through them and fill the capillaries. The result is seen in the flushed face and reddened eyes ; but a similar effect is produced in the brain (causing excitement and talkativeness), also in the stomach (causing a sensation of warmth), and in all the other organs of the body.

After long-continued drinking the blood-vessels become fatty and liable to burst.

The size of the arteries depends on the state of muscular fibres which form rings around them, and which are kept steadily contracted by an influence passing along the nerves. Now alcohol paralyses those nerves ; so the muscular rings relax, the arteries stretch under the pressure of the hot blood which pours through them in great volume; hence the flushing and feelings of warmth which are caused by alcoholic liquors. The nerves gradually recover when the influence of the alcohol has passed off and the arteries regain their usual size.

But if drinking habits are continued, the arteries are seriously injured ; fatty changes take place in their walls, which becomes too weak to withstand the pressure of the blood inside. Hence they are apt to become greatly distended and even to burst ; and when this happens in the brain it rapidly causes death by apoplexy.

(3) Alcohol affects *the heart* in two ways. First, it makes the

heart beat more rapidly and more forcibly. This effect lasts about fifteen minutes ; and then the heart beats more slowly and feebly than before. If, however, a large quantity of alcohol be swallowed the heart's action is reduced both in force and frequency, from the first, and may even be stopped altogether.

These facts are most important, and deserve a full explanation. The first effect of the alcohol is to irritate the mouth and the stomach : from them a message is sent to the heart through the nerves : and so "reflexly," the heart is urged to greater activity.

Soon, however, the alcohol gets into the blood-stream, reaches the heart, and acts on it "directly"—the result being a lessened activity. The heart is depressed and beats more slowly and feebly.

The excited action of the heart is then followed by a stage of depression, which induces a craving for more liquor. If this be yielded to, and the stimulus be habitually applied, the structure of the heart gradually deteriorates and its power is greatly reduced. It cannot squeeze out all the blood at each beat ; and the incoming blood over-distends it. It is thus liable at any moment to cease working ; and when the circulation is stopped, death at once follows.

The muscular wall of the heart undergoes fatty changes owing to the constant toxic condition of the blood. Hence the gradual failure in power, the yielding of the walls, and the final stoppage or rupture.

The action of alcohol upon the heart and blood-vessels is of great importance. In cases of sudden illness when the vessels are narrow and the heart is labouring to press blood into them, the effect of alcohol is to relax the arteries and urge on the heart to greater effort. Hence its value in such an emergency. But in health this action is not required : and if alcohol is taken habitually, it causes fatty changes in both heart and vessels, which seriously interfere with the proper circulation of the blood, and may at any moment stop it altogether.

QUOTATIONS:

"If no high fever be present, if the heart continue sufficiently vigorous, and food be well-taken, alcohol is unnecessary."—*Sir Dyce Duckworth.*

"Alcohol in small doses causes the heart to beat more rapidly and more strongly. In larger doses it becomes depressent."—*Professor Waller.*

"It must be remembered that the effects just mentioned are reflex, that is, are due to the local action on the stomach, before any of this has been absorbed. They are modified by the action of the alcohol after it has been absorbed."—*Sir Lauder Brunton.*

"The direct action of alcohol on the heart muscle tends to enfeeble its contractile power."—*Dr. Rolleston.*

"Alcohol is often recommended as an aid to a weak heart and to a feeble digestion, but it is so only temporarily, and always tends to enfeeble a weak heart and to lessen the power of a feeble digestion."—*Dr. Balfour.*

QUESTIONS:

1. What is blood composed of?
2. What keeps it constantly in motion?
3. Name the tubes through which the blood passes?
4. What are the four cavities in the heart?
5. How does the heart act?
6. What purposes are served by the circulation of the blood?
7. What helps to make healthy blood?
8. How does alcohol affect the blood?
9. What changes are apt to occur in the vessels?
10. Describe the action of alcohol on the heart? (1) reflex; (2) direct.

CHAPTER V.

THE MUSCLES.

Muscles—their Structure—their Mode of Action—the Effects of Exercise—Rules—How Alcohol Affects the Muscles.

Introductory. Every movement in the body is due to muscular contraction. The voluntary muscles number 400 ; the involuntary ones are still more numerous. Delicacy of action depends on the co-ordination of the various muscles; power and endurance depend on their size. In either case training is necessary ; the nerves must also be healthy and the blood rich and pure.

Physical exercise is of the greatest importance; but it needs regulation in order to secure the best results.

Alcohol lessens co-ordination of the muscles for a time after a single dose, and permanently if regularly indulged in.

It seems to increase the vigour of the muscles at first ; but this effect is transient, and soon the previous languor returns. Thus its real action is to dissipate energy ; and "when prolonged exertion is required it is eminently harmful."

Muscles. There are 400 muscles in the body. They form the thick masses which cover the bones and are covered by the skin. In an animal, the flesh or lean meat is composed entirely of muscle ; it may be separated into various layers and pieces; each muscle is made up of a number of threads about half-an-inch long, and at its end it is firmly attached to a bone.

In a muscle, each bundle of threads is surrounded by a fibrous sheath which unites it to the other bundles and binds the whole into one mass. Through the sheath passes a nerve which conveys the message from the brain. Through it also pass arteries to supply fresh blood and veins to remove the impure blood. The muscle has at each end a fibrous band or cord (tendon), which attaches it to the bone.

Muscular Action. When we wish to move any part of the body, a message is sent from the brain along a nerve to a muscle. At once a change takes place. The muscle becomes shorter, thicker, and firmer; its ends are thus drawn more closely together: the bones are pulled and the desired movement is brought about. Thus, when the hand is raised to the shoulder, the muscle that lies in front of the arm above the elbow (Biceps) is felt to contract: when the arm is stretched out, the biceps relaxes while a muscle at the back of the arm contracts. Hence, before any action is possible, a man must have an active brain, healthy nerves, and vigorous muscles. The thicker a muscle, the more powerful it is.

But no action is completed by a single muscle. Every effort calls into play a number of them—some to aid, others to regulate, the movement of a limb. Thus perfect accuracy and grace of motion depend on the harmonious contraction of many muscles, and can only be acquired by practice.

The contraction of a muscle is most easily understood by watching a worm (which is practically a hollow muscle). When at rest it is long, thin, and soft; when tapped it immediately becomes short, thick, and hard, and its ends are drawn nearer each other.

A muscle acts on a bone like a force applied to a lever; the power and rapidity of its action depend on its point of attachment to the bone. There are three systems of levers, and each is represented in the body:—

(1) Pushing an object away with the hand—effected by the muscle at the back of the upper arm. (An example of the first class of lever.)

(2) Standing on tip-toe—effected chiefly by the large muscles of the calf. (An example of the second or most powerful class).

(3) Lifting an object by the hand—done by the biceps. (An example of the third class which allows of the greatest rapidity of action.)

Some muscles have only one end fixed to a bone ; the other end is attached to the skin. The changes in facial expression are due to the action of such muscles.

Most of the muscles acting on the bones and skin are under the control of the will (voluntary) ; these are called into action by a message from the brain. But there are many others over which the will has no control (involuntary) —for example, the muscular walls of the stomach, heart, and blood-vessels. These are called into action by messages from nerve centres of their own, situated mostly in the spinal cord.

The results of muscular activity are very important. When the exercise is moderate and regularly taken the muscles increase in size and power, and the bones grow in thickness, and often in length too.

During active exercise the breathing becomes deeper and more rapid ; the heart beats more vigorously ; the skin becomes hot and red, and pours out much perspiration. That is followed by feelings of thirst and hunger, and (if the exercise is not continued too long) it leads to a freshening of the whole system, with increased brain power during the day, and sounder sleep at night.

A regular course of gymnastics has been known to add several inches to the expansion of the chest, while both muscles and bones increased in size. This was most evident in persons who were still growing ; their vigour and power of endurance were markedly augmented.

A muscle in active service needs a larger supply of blood than one at rest. Hence the artery, which conducts the blood to it, relaxes and allows a full stream to pass through. The muscle uses up much of the nourishment and oxygen in the blood—an extra supply is required—hence the breathlessness and quickened action of the heart. More blood is sent to the lungs ; more oxygen is taken up ; and the whole circulation becomes more rapid. As the blood becomes poorer in nourishing matter a feeling of hunger begins to be felt. Food is eaten with greater relish and is more thoroughly digested. Meantime, the waste matters which are apt to collect in the system during inaction are burned up by the extra oxygen in the quickened circulation, and are got rid of in the form of carbonic acid by the lungs, and in other forms by the skin and kidneys. Thus the whole body feels refreshed and the brain is more able for work.

Rules for Exercise. "Physical exercise is of the greatest importance to mankind through life, and in the young and growing its value is simply beyond calculation." But it must be carefully regulated if the full benefit is to be gained, for "while exercise increases growth, over-exercise stunts it."

(1) The exercise should be such as to call into action all parts of the body, and be interesting too.

(2) It should be taken in the open air if possible; and flannel should be worn next the skin. No tight clothes.

(3) The time chosen should be neither just before nor just after a meal.

(4) If severe, the exercise should be begun gently, and given up when fatigue is felt.

(5) As much exercise should be taken every day as would correspond to walking about two miles briskly.

The reasons for these rules are easily understood. One-sided exercise developes part of the body more than the rest; merely mechanical work causes no mental stimulus, and soon becomes drudgery.

Much oxygen is needed; hence the necessity for pure air. Much sweat is given off; therefore the skin should be covered by some absorbent material.

Hard work just before a meal leaves the stomach exhausted; just after the meal it will cause indigestion.

If active service is begun suddenly, the heart fails to respond to the extra demand upon it: hence palpitation and oppression. If continued after fatigue has come on, work is performed at the expense of the muscular substance and does more harm than good.

A quick walk of at least two miles every day is found to be necessary if a man is to keep in good health; hence exercise of some kind requiring as much energy should be taken daily.

Among healthy forms of exercise may be mentioned:—

Walking briskly, with an end in view if possible, and not so far as to cause fatigue.

Rowing and *Cycling*, with occasional rests to avoid overstrain.

Golf,—"one of the best games that can be played at, from boyhood up to old age."

Cricket and Football, if the players are about the same size and age, and the game is played fairly.

Tennis, if not played too long. Two hours should be the limit.

Athletics and *Gymnastics*, if the exertion be carefully regulated—gentle and easy at first, gradually increased in speed and difficulty—otherwise there is a risk of overstrain.

Manual Work,—a useful indoor exercise and often of much service in after-life.

The most refreshing form of recreation is a short active exercise, calling into play all the muscles, and causing mental stimulus at the same time, as in a game.

The *clothing* worn during the game may be light even in cold weather if the body is kept in active motion; but it should be changed immediately afterwards and warm clothing put on.

The *food* required varies with the work to be done; for hard work (*e.g.* that of a navvy) extra fatty and starchy food is necessary, but the amount of albuminous food need not be altered.

For racing a careful course of training is necessary, extending over a month. The diet should be plain but liberal, and eaten at regular intervals. No more food should be taken than what is allowed to allay thirst.

The kind of recreation best suited to a man depends on his daily work. If that consists of brain work, then muscular exercise of some kind is essential and by calling into action his muscles it gives rest to his brain. For one engaged in manual labour, intellectual work will be found of most service. But if both brain and muscle are tired, further invigoration is only to be obtained by sound sleep.

Errors in Exercise. The two serious errors often made consist in taking either too much exercise or scarcely any at all.

(1). If too little exercise is taken the body gets sluggish, the circulation is slow, appetite and digestion are impaired, and work of any kind becomes a burden.

(2). If the exercise is too severe or too long continued, both heart and lungs are apt to be overstrained and fatigue is felt a long time afterwards. Any work is excessive if the fatigue is not removed by a few minutes' rest.

Alcohol and the Muscles. When a quantity of liquor is swallowed the alcohol is absorbed into the blood, and carried in the course of the circulation to the muscles. Its first action is to excite them to greater effort; but it supplies no force-giving material and the muscles soon use up their reserve supply. Thus the period of increased activity is followed by a period of weakness and fatigue which lasts much longer than if no alcohol had been taken. Hence it is a mistake to think that alcoholic liquors increase the strength of the muscles. It is found, on the contrary, that heavier work and more of it can be done when no alcoholic liquors are taken.

This has been proved by a careful experiment carried out on three soldiers by the late Dr Parkes of Netley. They had to march 20 miles a day for 6 days carrying a weight of 51 lbs. each. They received their usual rations, and during the march, they had either rum, or extract of meat, or coffee, with half a pint of water. Each man received rum on two days (not successive days), meat extract on other two, and coffee on the remaining two. At the end of the experiment all three agreed that the meat extract gave most strength for marching, and that the coffee came next, and was to be preferred to the rum, because the latter merely enabled them to put on a spurt for a couple of miles and then left them weaker than before.

A striking proof that alcoholic liquors are not required by men doing very hard work is furnished by the experience of the soldiers under Lord Wolseley in the Red River Expedition. They had to march several hundred miles through Canadian forests in winter. No spirits were issued: tea was used instead. The soldiers completed their march and returned in perfect health.

Alcohol affects both the nerves and the muscles. By exciting the nerves it gives a feeling of greater energy ; by acting on the muscles directly it makes them use up their reserve of food material. Thus, for a short time, extra work may be done, but soon the reserve is exhausted ; the circulation bringing a fresh supply becomes slower, while the alcohol in the blood makes it less nourishing ; the nerves are dulled ; and a feeling of fatigue comes on, which renders further work irksome or impossible.

When the habit of drinking is continued, it gradually makes the muscles deteriorate—many of the delicate fibres turning fatty. The result is an unsteadiness of hand and eye that makes the performance of fine work impossible.

Thus the action of alcohol on the voluntary muscles resembles that on the heart. It urges them at first to increased activity, and in an emergency, when a great effort must be made for a short time to save life, it may be of service ; but, as a help in continuous hard work, it is useless.

QUOTATIONS :

It must be remembered that alcohol does not in itself give strength. It only enables a man to draw more rapidly upon his resources.—*Sir Lauder Brunton.*

Its action consists in bringing out the reserve powers for a short effort, and not in restoring or husbanding sources of energy. It may enable a man "to spurt," but not "to stay." It is dissipative rather than conservative of energy.—*Dr Rolleston.*

The systematic administration of alcohol for the purpose of giving and sustaining strength is an entire delusion.—*Sir B. W. Richardson.*

My opinion is that the most severe labours and privations may be undergone without alcoholic stimulus, because those who have endured the most had nothing else but water.—*Dr Livingstone.*

Alcohol is of service only for emergencies of short duration ; it is eminently harmful when prolonged exertion and endurance are required.—*Prof. Waller.*

Men in a healthy condition, and supplied with a sufficient amount of food, retain their health and are capable of performing the most arduous labour in every variety of climate without alcohol.—*Prof. Fraser.*

QUESTIONS

1. How many muscles are there in the body?
2. How do they act?
3. What are the good effects of muscular activity?
4. Give five rules for exercise. State the reasons for each.
5. What is the effect of too little exercise? What of too much?
6. How does alcohol affect the muscles?
7. Give examples of hard work well done without it.

CHAPTER VI.

THE SKIN.

SKIN—Its Structure—its Purposes. How to keep it Healthy—Baths Clothing. Effect of Alcohol on the Skin. The Kidneys—How affected by Alcohol.

Introductory. The Skin is tough and elastic. It serves to protect the body, moderate the temperature, and remove some of the waste matters. It consists of nerves, capillaries, and sweat-glands, embedded in a fibrous elastic structure, and covered by the cuticle. The skin must be kept clean and in good working order; otherwise the health is sure to suffer. Daily bathing in tepid or cold water, suitable clothing, and active exercise are necessary.

Alcohol injures the skin in many ways. It benumbs the nerves, relaxes the capillaries, and lowers the vitality of the skin; and thus exposes the whole body to greater risk from accident or disease.

The Skin serves four chief purposes. It protects the body; it pours out oil and sweat; it is sensitive; and it helps to regulate the temperature of the body.

The skin consists of two layers:—the cuticle forming the surface, and the true skin below. The cuticle is constantly being rubbed off as scales and as constantly being renewed from beneath. The true skin is tough and elastic; it thus affords sufficient protection without interfering with the movements of the body.

In it lie the *sweat-glands* from which fine tubes pass through the cuticle, and open on the surface. Sweat is constantly being poured out—imperceptibly in winter, but freely in summer, when it may be seen as drops. It serves to keep the skin moist and cool. Round the roots of the hairs, oil is prepared in special glands and assists in preserving the hair.

There are many *nerves* in the skin; they end in little oval bodies which are very numerous at the points of the fingers. When irritated these send a message along the nerve to the brain, and so the person feels the hardness, or sharpness, or heat of an object.

In the skin, lastly, are many *capillaries* through which a constant stream of blood is flowing. When the body gets very warm, arteries leading to the skin relax; much blood enters the capillaries and so the skin becomes red and hot. On the other hand, in winter the surface arteries are usually contracted; little blood passes under the skin, which is therefore of a pale colour.

The thin cuticle (or epidermis) consists of several layers. The uppermost is constantly being worn off as fine dust or scales; but, when there is much friction, it becomes thickened: and, if the friction is excessive, it is raised by fluid and forms a blister. From the lower layers new cells are constantly growing up to take the place of the scales.

The true skin (or derma) is formed chiefly of fibrous tissue; hence its toughness. It also contains elastic and muscular fibres; hence its power of stretching and wrinkling. It is this part of the skin of animals which is made into leather.

The sweat-glands consist of tiny tubes coiled up in the true skin. From each one a sweat duct winds like a corkscrew through the cuticle and opens on the surface. These openings may be seen with the help of a magnifying glass. The sweat-glands number over two millions, and pour out about two pints of sweat daily.

The blood-vessels and nerves lie in the true skin; they do not extend into the cuticle, which may thus be pricked without any pain or bleeding.

Errors in the Management of the Skin. (1) If the sweat and oil and scales are not frequently washed off, they are apt

to be rubbed, with the dirt on the surface, into the openings of the sweat glands. Hence the sweat is prevented from getting out, and the health is injured.

(2) If the body is not sufficiently clothed in cold weather, much heat is lost from the skin, and the person is very apt to "catch cold."

Sweat is an excretion—something that has to be got rid of. Hence if the ducts are blocked, the sweat must be removed in some other way. This throws extra work on internal organs (especially the lungs and kidneys), and leads to ill health and even death. A child was once coated with gum and covered with gold leaf to represent an angel, and died in a few hours with signs of blood poisoning.

Besides, the sweat and oil begin to putrify if not frequently removed, and this causes a very unpleasant smell.

"A cold" is often the result of a draught of cool air on the neck when the skin is warm. By using a sponge-bath every day the skin is trained to bear sudden changes of temperature, and so the person is not so apt to 'catch cold."

Baths are used for three purposes :—(1) to cleanse the skin ; (2) to stimulate the whole body; (3) to soothe the nervous system.

For cleansing the skin, *tepid water* and soap are employed. The whole body should be washed thoroughly once a week, but the hands and face ought to be cleansed every day.

Water alone would remove the sweat, but not the oily substance to which the dust and smoke adhere.

Soap dissolves the oil ; it also softens the surface of the skin and allows of the thorough removal of the old scales as well as all the dirt.

Turpentine is sometimes employed if any bad smell is left on the skin. It removes every trace of oil and the disagreeable odour which adhered to it.

For stimulating the body, *cold water* is used. Every morning the skin should be sponged over with it, and rubbed dry with a rough towel. A dip into cold water is more refreshing for those who can stand it ; in summer a bath in the sea is the most stimu-

lating of all. But for sea-bathing some precautions should be taken.

(1) The time should be before breakfast or two hours at least after it.

(2) While in the water the body should be kept actively in motion.

(3) If shivering comes on, or a feeling of chilliness, it is well to come out at once.

(4) Before dressing, a rough towel should be used, and vigourous friction applied over all the skin.

(5) After dressing, a little brisk exercise is beneficial.

The first effect of the cold water is to produce a slight shock to the nervous system, shown by the quicker breathing ; it also makes the blood-vessels in the skin contract. But soon after coming out, the bather feels a glow of heat come over his skin ; for the blood-vessels then are relaxing and the warm blood again reaches the surface. This re-action is greatly aided by rubbing the skin well.

The result of the bathing should be to refresh the whole body and make it more able for work and much less liable to "catch cold." But if the glow of heat does not come on—if, instead, the bather feels chilled and languid—it shows that some error has been made. Either he is not strong enough to bear water so cold or he has stayed too long in it. The reasons for attending to the rules for bathing are as follows :—

(1.) To bathe just after a meal interferes with digestion and sometimes causes sickness.

(2.) To stay too long in the water (and especially if inactive) chills the body unduly and depresses all the vital powers.

(3.) To omit the rubbing and the exercise afterwards delays the reaction and reduces the benefit derived from the bath.

A *hot water* bath is used to soothe the nervous system when the person is fatigued or ill. If taken occasionally after a hard day's work and just before bedtime it is useful. But, if taken often, it is weakening and renders the person very liable to a chill afterwards. This risk is lessened, but not removed, by a spray of cold water just after the bath.

Clothing should be warm but not heavy, and closely fitting without being tight. The best underclothing is made of flannel, and it should be changed about once a week. Linen or cotton is better for use at night. When passing from a warm to a cold atmosphere a person should put on extra clothing. "Clothing should keep the skin warm, but not moist except under active exertion."

Heavy clothes are oppressive and they are not so warm as much lighter material if worn double. Tight clothes round the chest interfere with the proper expansion of the lungs, and if very tight they displace the heart and the liver and seriously injure the health. Tight bands round the neck or the knees interfere with the circulation of the blood by compressing the veins.

The throat should not be muffled up except in very cold weather; but the chest should always be well protected.

Flannel allows moisture to pass through readily, but it is a bad conductor of heat. Hence it is the best material for underclothing: it keeps the body warm in winter, and cool and comfortable in summer.

Linen checks the evaporation of sweat, which condenses on its inner side and so forms a chilling layer next the skin. It is not a good material for underclothing which is to be worn during the day.

Cotton is better than linen, but it is less useful than flannel.

Alcohol and the Skin. (1). Alcohol lessens the delicacy of feeling in the skin; it also brings on a trembling of the muscles; hence fine work cannot be done.

(2). It causes a change of colour in the skin, which at first becomes red all over. But when alcohol is habitually taken the colour becomes darker and less uniform; hence the dull mottled hue of a drunkard's face.

(3). It depresses the life of the skin directly, so that slight wounds heal slowly, and are very apt to be the seat of a spreading inflammation (erysipelas).

(4). Its effect in cold weather is specially dangerous, for it allows the heat of the body to escape rapidly through the skin. [For further details see page 56.]

The partial loss of feeling and power is due to the action of alcohol on the nerves. [See page 64]. The change in colour depends on its action on the blood and blood-vessels. [See page 36].

The Kidneys. The blood, while passing through the muscles, takes up the waste matters that are formed there during exercise. These waste matters must be got rid of, if the blood is to remain healthy. They are removed in three ways—through the lungs carbonic acid is given off; through the skin other impurities escape in the sweat; and what remains is removed by the kidneys.

The kidneys are two oval bodies lying in the small of the back—one on each side. Through them the blood is constantly passing in large quantities, and in its passage it is relieved of the excess of water and many substances which the water contains in solution. But the albumin and other nourishing matters are not affected; these pass on with the pure blood.

The kidneys and the skin have a similar work to do, and can relieve each other to a certain extent. Thus, in summer, when the skin is throwing off much sweat, the kidneys are less active: while in winter the skin is almost dry, and more work is done by the kidneys. Hence there is a danger in suddenly checking perspiration as by a cold bath when one is sweating freely. The effect is to throw extra work suddenly on the kidneys, which are thus apt to suffer from congestion.

Alcohol and the Kidneys. The effect of alcohol on the kidneys is a slowly advancing inflammation, which completely reverses their action. The blood is not properly purified and much of the food material in it is allowed to escape. Thus the whole body becomes ill-nourished, dropsy is brought on, and death soon follows.

The congestion of the kidneys, caused by frequent drinking, gradually leads on to inflammation, which destroys a large part of the kidney. Hence less water and waste matters are withdrawn from the blood; but much albumen—the most valuable food material in it—is allowed to pass out. The blood is thus left impure, and much less nourishing than before.

QUOTATIONS:

"Chronic alcoholism weakens the resistance of the body generally and tends to favour the incidence of disease. It is notorious how badly alcoholics bear acute disease or injury."—*Dr. Rolleston.*

"Injuries, which to other people would be but slight, are apt to prove serious in them: and when it is necessary to perform surgical operations upon them, the risk of death is very much greater than in others."—*Sir Lauder Brunton.*

"Out of every hundred patients that I have charge of at the London Hospital, seventy of them owe their ill-health to alcohol."—*Sir Andrew Clark.*

QUESTIONS.

1. What are the two layers of the skin?
2. What three kinds of structures lie in the skin?
3. What purposes do these serve?
4. How may the skin be kept healthy?
5. Explain the effect of a cold bath, and of a hot bath?
6. Give five rules for bathing in cold water.
7. What kind of clothing is most healthy, and why?
8. In what ways does alcohol affect the skin?

CHAPTER VII

ANIMAL HEAT.

Heat of the Body—how Produced—how Lessened—how Regulated. Effect of Alcohol in Cold Weather.

Introductory. In health the bodily temperature is constant—98½° F. on the surface, or 100° F. inside. Heat is developed in the muscles and glands: it is lost through the skin. A delicate nervous mechanism regulates both production and loss. Extra food and exercise increase the production of heat. Extra clothing diminishes its loss. Thus man may keep healthy in any climate.

Alcohol disturbs this delicate arrangement. It lessens the production of heat: it greatly increases the loss by paralysing the vessels in the skin. Hence the special danger of using alcoholic liquor in very cold weather.

The Heat of the Body is produced chiefly in the muscles where the food material is slowly burned; it is lost chiefly from the skin. But the gain and loss of heat are so delicately balanced, that the temperature of a healthy person is always the same—100° F. inside the body, and about 98½° F. at the surface.

In winter more food is eaten, and more oxygen is breathed in: more active exercise is taken, and so the muscles produce extra heat. Besides a change takes place in the skin itself. The blood-vessels there contract and allow only a little blood to pass through

them : thus the warm blood is prevented from being cooled, and the heat of the body is maintained.

In summer lighter clothing is worn, but the state of the skin also assists in keeping the body cool. The blood-vessels there relax and much blood reaches the surface : at the same time the sweat-glands are active — much sweat is poured out and by evaporation carries off the extra heat.

If the nervous mechanism, that influences the skin, is working well, there is little danger in passing from a hot into a cold atmosphere, for the skin-vessels soon contract and lessen the loss of heat. But if the person is delicate he is very apt to "catch cold." This tendency is greatly diminished by a cold bath or cold-sponging every morning. It is increased by taking hot baths.

All kinds of food are heat-giving—fatty food in particular. The muscles produce four-fifths of the entire heat of the body ; the rest is formed in the liver and the brain.

The mechanism, by which the loss of heat is regulated, consists of a nerve centre in the spinal cord which sends the message, nerves which carry it, and blood-vessels which receive it. When the blood has no heat to spare the centre sends a message which makes the vessels contract. When the blood tends to become overheated, a message is sent which makes them relax. Thus the temperature of the blood is kept constant.

Alcohol and Animal Heat. Alcoholic drinks were formerly supposed to increase the heat of the body. It is now known that their action is entirely different. The feeling of warmth is due to the escape through the skin of heat which the body can ill spare.

Soon after a *small* amount of alcohol has been taken, the skin becomes red and hot, because an extra quantity of warm blood is allowed to circulate under the skin. When this occurs in cold weather, much heat is lost, and the blood returning cools the internal organs.

If a *large* amount of alcohol has been taken, the cooling is carried further, both the inside and the surface of the body become colder than usual. At the same time a tendency to sleep comes

on, and if a person yields to this on a frosty day he is certain to be frozen to death.

In a healthy man the temperature of the surface is 98½° F., that of the inside (*e.g.* under his tongue) is 100° F.

1. Now if alcohol be taken, the first effect is that the surface temperature rises to nearly 100° F. This is simply due to the free distribution of the warm blood to all parts—produced by the relaxing of the arteries. The skin feels warmer, but the blood is being rapidly cooled.

2. If a larger amount of alcohol has been taken—sufficient to cause excitement—the cooling process goes further. The temperature of the skin is reduced to the normal (*i.e.* 98½° F.) and then falls one degree lower if the person is exposed to cold air. It will take two or three hours in a warm atmosphere before he recovers his natural heat.

3. If so much alcohol has been taken as to cause intoxication, a very serious amount of cooling is produced. The surface temperature may fall to 95½° F., while that of the blood is very little higher. A man in this condition is liable to suffer from congestion of the lungs or other internal organs ; and it will take a day at least in a warm room before he regains his natural warmth.

4. If the cooling process is carried any further, it brings on sleep, which is very likely to end in death.

A simple experiment was once performed to test the effects of alcohol on the heat of the body. Two animals were put into a chamber which was kept at a temperature 10° below freezing point. One of them had previously been made to swallow a quantity of alcohol. In so cold an atmosphere both the animals fell asleep. When removed afterwards to a warm room, one awoke uninjured ; but the other, which had swallowed the alcohol, never awoke. It had been frozen to death.

Another experiment, which was carried out by men upon themselves, shows, in a terrible way, the power of alcohol to rob the body of its heat. A party of several men lost their way on a North American plain during a snow-storm, and had to spend the night in the open air without a fire. A proposal to take whisky was made, under the idea that it would keep them warm. Some declined, slept soundly, and awoke well ; others took a little, and

felt the cold badly; a few drank freely, and suffered from severe frost-bite; some who took a large quantity were so severely frost-bitten that they never recovered; and those that drank till they were intoxicated were dead by daylight.

The experience of Arctic travellers, leaders of military expeditions, and of many others go to support the statement:—"Alcohol does not keep out the cold; it lets out the heat."

QUOTATIONS:

"Alcohol tends to lower the temperature by increased loss of heat, and to some extent by lessened oxidation; while the power of the body to resist cold is much reduced by it."—*Dr. Rolleston.*

"The experience of all Arctic travellers tells the same story, that indulgence in alcohol is almost certain death when the external cold is great."—*Sir Lauder Brunton.*

"It was quite remarkable to observe how much stronger and more able our men were to do their work when they had nothing but water to drink."—*Sir John Ross.*

"The popular plan of administering alcohol for the purpose of sustaining the animal warmth is an entire and dangerous error, and when brought into practice during extremely cold weather it is calculated to lead to fatal consequences."—*Sir B. W. Richardson,*

"The use of alcohol is very limited, while its abuse is productive of many injurious consequences. Its employment as a daily beverage cannot be justified on the ground that it increases the capacity for work, that it makes the body warm, or that it acts in ordinary conditions as a food."—*Professor Fraser.*

QUESTIONS:

1. What is the usual temperature of the body in health?
2. How is the heat increased? How diminished?
3. What regulates the temperature?
4. Describe the effect of alcohol on the body in cold weather?
5. Explain that effect?
6. Give examples of the special danger of alcoholic liquors in very cold weather.

CHAPTER VIII.

THE BRAIN AND THE NERVOUS SYSTEM.

The Brain—the Spinal Cord—the Nerves: their Structure and Purposes. Rules for Brain Work—Some Cautions. Sleep—its Necessity. Effect of Alcohol on the Brain, Spinal Cord, and Nerves.

Introductory. The Nervous System consists of brain, spinal cord, and nerves. The *brain* is the centre of conscious sensation and action. The *spinal cord* is largely a centre of unconscious action (regulating the various organs of the body automatically). The *nerves* convey messages from all parts to these centres or from them back again to muscles and glands.

Life depends on an active nervous system. Good health requires one that is perfect in each part, harmonious in action, and kept in good working order by pure blood and suitable exercise and rest. But the full measure of life requires thorough training and education of every part, and especially of the highest centres of all—the faculties of observation and judgment, the character and the will.

Alcohol interferes seriously with the working of the nervous system, first lowering the self-control, then dulling the senses, lessening co-ordination, weakening the muscles, until the paralysis affects every part.

Continued indulgence in liquor causes disease in nerve and brain—leading to insanity and crime, and bringing the man to ruin.

The Nervous System. If a finger be pricked by a needle it feels sore, and is at once drawn back. This happens so quickly that one may think the finger alone is affected. But in reality a message is sent from the finger through a long white thread, called a nerve, to the brain, which lies inside the skull—only then can we feel the prick. At once the brain sends a message down another nerve to a muscle, which contracts, and so pulls the finger back. Thus one kind of nerve (sensory) carries a message up to the brain to cause sensation, and another kind (motor) carries a message down from the brain and so brings about motion.

Both of these lie close together in a large nerve on the inner side of the elbow (often called the "funny bone"); when this is twitched, pain is felt in the little finger and the whole hand jerks, because a message has been sent both up and down from the elbow. If that nerve were cut, a needle pushed into the little finger would cause no pain, and some parts of the hand could not be moved.

The whole body is full of nerves; many of them are collected into one bundle, and form a thick cord lying inside the spine or back-bone. This is called the spinal cord.

Both nerves and spinal cord end in the brain, which is a mass of delicate white matter lying inside the head, and well protected by the skull. The brain receives messages from the skin, the eyes, the ears, and other parts, and is thus the organ of sensation. It also sends messages to the muscles of the arms, the legs, and elsewhere, and makes them move; it is thus the organ of will. All thinking and remembering and imagining are also done by the brain. It is the centre of the nervous system.

A healthy brain needs plenty of nourishment and rest, and very careful training. Every day it should be exercised in a variety of ways. Habits of close observation sharpen the senses; drill and dancing, singing and playing music lead to quickness and grace of action; the memory and thinking powers ought also to be trained; habits of order and regularity, of thoroughness and perseverance

deserve to be cultivated. But it is most important to acquire force of character and the habit of self-control—to make oneself do what is right even when it is not agreeable, and to restrain oneself from doing anything, however pleasant at the time, that would be a source of misery and regret in the future.

The Brain is the organ of thought, of feeling, and of will. It lies inside the skull, and from it nerves stretch like white cords and threads all through the body. The surface of the brain is of a grey colour, and is disposed in many folds or convolutions : it is the most active part, for here messages from all quarters of the body are received and others are sent off. (In civilized men the folds are more numerous than in savages). The rest of the brain is white, and serves to conduct the messages to and from the surface.

Many blood-vessels enter the brain to supply it with blood ; and many nerves leave it. A large bundle of nerves passes along the centre of the spine and forms *the spinal cord.* From both brain and spinal cord *the nerves* spread like the branches of a tree throughout the body : some of these end in the skin (sensory nerves), their purpose is to carry a message from the skin to the brain : others end in muscles (motor nerves), their duty is to carry a message from the brain to the muscle. By means of sensory nerves we see, hear, and feel things around us : by means of motor nerves we can move and speak and breathe.

The brain is thus the centre of the nervous system. It receives information from every part of the body, and so becomes the seat of *intellect.* It sends its orders out through all the body to muscles, and so becomes the organ of *will.* It is also the seat of memory and imagination ; of reason and emotion.

The brain is surrounded by three delicate membranes, and is enclosed within a firm case formed by the bones of the skull. It is thus securely protected. The brain consists of nerve-cells and nerve-fibres. The cells are very small bodies which receive and send out messages. They form the grey layer on the surface. The fibres are fine threads which carry the messages. They form the white substance of the brain.

The spinal cord also consists of nerve-cells and fibres, but in it the cells are in the centre and the fibres are at the surface.

All conscious mental work (such as receiving sensory impressions and sending out motor impulses) is done by cells in the brain. Most of the unconscious work of the body (as the beating of the heart) is controlled by cells in the spinal cord.

The brain is supplied with blood by numerous blood-vessels. When a man is thinking deeply these vessels dilate and allow a large quantity of blood to enter the brain. When he is asleep they contract and only a small quantity is allowed to circulate there.

The nerves are like telegraph wires in some respects. They consist of a central thread surrounded by a fatty sheath and they conduct messages at the rate of nearly 100 feet a second.

Thus both feeling and action are dependent on a healthy state of the brain and nervous system. Delicate feeling and accurate motion require the brain and nerves to be well-trained besides being well-nourished.

Rules for Brain Work. The brain requires careful training and exercise, as well as good nourishment and sufficient rest.

(1). The training ought to be varied and interesting but limited in duration every day. By careful observation the eye, ear, and fingers with their sensory nerves are exercised. By practice in fine work (singing, dancing, violin-playing, etc.) the motor nerves and muscles are trained. By education, the memory is stored and the imagination gets materials on which to work. Still higher parts of the brain are called into action by reverence, courage, and self-control.

(2). While the brain work is continued, it ought to be thoroughly done — by close attention and steady perseverance. Habits of order and regularity should also be cultivated.

(3). When dulness or fatigue is felt, the brain work should be stopped for the time. A spell of two hours is long enough for perfect attention to be given to any one subject. A change of study may give relief by exercising another part of the brain; muscular work in the open air is a greater relaxation; but if body and brain are wearied, sleep is necessary.

(4). Abundance of simple wholesome food and fresh air are essential for perfect brain work.

Mental training is as necessary for brain health as muscular training is for the muscles. But it must be conducted daily and systematically, carefully regulated in nature and amount, and of gradually increasing difficulty.

Close observation exercises chiefly the back of the brain ; practice in fine work employs the upper part ; while efforts of memory and reason call into action the front. Hence one form of work is a relaxation to a brain tired with another, and none of these should be omitted in a proper course of training.

Without a habit of quick and accurate observation, the man passes unnoticed much that is interesting, and his life is the poorer.

Without the acquirement of agility and grace of action, his movements become clumsy and often futile.

Without the early exercise of memory and reason, the use of these faculties is much restricted, and the growth of the intellect is stunted.

But the higher departments of the brain require as careful training. There is a sense of justice, of truth, and of honour which is apt to remain useless if not exercised. There are acts of courage, of obedience, and of self-control which become impossible unless these habits are developed.

"The power of self-control is the highest faculty of the nervous system ; its education should begin in early infancy, and should be steadily cultivated and perfected all through life."

Errors in Brain Work. (1). *Too little exercise.* The absence of education and training leaves the highest powers of the mind weak and useless. The body thus becomes a prey to superstitions and the passions of the lower nature.

(2) *Too much Exercise.* Hard brain work, accompanied by worry, undoubtedly damages the brain ; by itself it rarely does harm ; however, if continued too long it leads to fatigue and overpowering sleepiness which enforces rest. But excitement with hard study is really dangerous ; for the brain is forced to continue at work long after it is exhausted. Sleeplessness and headache are sure to follow ; and, unless complete rest is taken, the brain may be seriously injured.

(3) *Excessive emotion,* such as anxiety, grief, or envy, is apt to interfere with healthy brain action. Even the long-continued use

of one of the intellectual powers (*e.g.* imagination) may cause the mind to lose its balance.

(4) *Want of rest* is the chief cause of much brain trouble. For, during sleep, the brain substance repairs itself, and gets rid of all the products of fatigue. With sufficient sound sleep every night a healthy brain is equal to almost any intellectual work. The amount of sleep required depends upon its degree of soundness. About eight hours is the average time needed, but many people can do with less sleep if it is undisturbed.

(5) *Want of proper nourishment.* This is due to disorders in the blood or its circulation, and these again depend largely on errors of diet (see page 13). The effect of alcohol upon the brain is particularly injurious.

In the brain, as in the muscles, exercise causes increased consumption of food material and oxygen, with increased production of waste matters. But, during active study, there is a full supply of blood which brings extra nourishment and carries off the effete matter. Thus, for a time, brain activity can be continued without difficulty. But at length the head begins to feel hot and tired. If now brain work is stopped the repairs are gradually effected, and the brain is ready to start again. But, if the brain is forced to labour on, the work is done at the expense of brain substance, and a state of congestion is caused which prevents sleep and leads to a headache next day. Such a condition is very dangerous and may bring on mental derangement.

Sleep is a state of lessened activity throughout all the body. The muscles are at rest: the brain is usually inactive; the heart beats less frequently; the breathing is deeper and slower. It is chiefly during sleep that the repairs of the body are carried on; waste matters are removed by the blood and gradually burnt up; much carbonic acid is breathed out; hence the need for plenty of pure air at night. Nourishment and oxygen are drawn from the blood, and stored up in the tissues for use during the day. Thus after sound sleep the body awakes refreshed, and able for renewed exertion.

Some precautions should be taken to secure sleep. Supper should be light, and it should be taken at least an hour previous to bedtime; some muscular exercise or only light brainwork should be undertaken before retiring for the night; the feet ought to be thoroughly warmed; and the room should be dark and quiet, airy and comfortable.

If the sleep is sound about eight hours of it are sufficient, and everyone should cultivate the habit of rising as soon as he is wide-awake. Dozing in bed after that makes the mind dull and listless all day. A cold shower-bath on stepping out of bed has an excellent effect in rousing the whole body.

Alcohol and the Brain. The effect of alcohol on the nervous system depends on the quantity swallowed. It may be divided into four stages.

(1) If only a little be taken, *excitement* is produced. The person's face is flushed. He is restless and talks rapidly. His feelings are more acute and his ideas flow freely. Then the excitement gradually wears off, and depression or drowsiness follows.

(2) If much alcohol be taken, *greater excitement with loss of control* is produced. The man's face has a darker flush. His movements are uncertain; gait is unsteady, and speech is thick. His senses are dulled; hence delicate actions become impossible. His mind is clouded; his ideas are confused; self-control begins to give way, and the man becomes quarrelsome or boisterous.

(3) When more alcohol has been taken it produces *intoxication*. The face is now purple; action is almost impossible; gait is staggering, and there is double vision. Sensation is almost destroyed. All sense of right and wrong is lost, and the higher faculties of the brain exist no longer.

(4) The last stage is that of *dead-drunkenness* which sometimes ends in death. The muscles are helpless; sensation is gone; memory and reason are abolished. The body lies like a log; only the breathing and the beating of the heart show that there is still

life in it. But the constitution of the man is seriously injured; and as the alcohol is got rid of and consciousness slowly returns, he feels utterly wretched.

Such are the effects that may follow a day's drinking. But if a large quantity of alcohol (*e.g.* a bottle of whisky) were swallowed at once, it would quickly cause the death of a man.

In each stage the alcohol affects different parts of the nervous system.

In the first it weakens the *nerves* that regulate the size of the blood-vessels throughout the body. Thus the vessels relax and much blood flows through them. In the face this causes the flush and feeling of heat; in the brain it produces excitement; in the other parts it brings about more rapid action followed by greater fatigue and depression.

In the second stage the alcohol weakens especially the *spinal cord*. Hence actions that are usually done almost unconsciously (*e.g.* walking) are rendered uncertain.

In the third stage the alcohol weakens the *brain* itself. The delicate balance and control of its various parts are lost. A state of partial paralysis is brought on.

In the fourth stage the *whole nervous system* is poisoned by alcohol. Complete paralysis of motion and sensation is produced; and if this extends to the heart and lungs it causes death.

When drinking habits are continued, the blood is never free from alcohol, and its constant irritating action causes other changes of a most destructive kind in the brain and the nerves. During the day a degree of numbness of the skin and trembling of the muscles is constantly present, while at night sleep is almost impossible. The intellect becomes weakened, the moral nature lowered, will-power and self-control gradually destroyed, till the mind itself begins to give way.

About 40°/₀ of all cases of insanity are due directly or indirectly to the effect of strong drink. One terrible form of insanity (called delirium tremens) is occasionally brought on by a bout of heavy drinking. The man imagines that he is being bitten by snakes and tortured by demons, and for several days he suffers from intense excitement and terror; he cannot sleep or even lie down, but goes

on acting like a wild beast. This sometimes continues until he drops exhausted and dies.

The brain has a special attraction for alcohol. After a drunkard's death more of the poison is found in his brain and liver than in any other part of his body, and its effect is seen in destructive changes in both these organs. The substance of the brain is much softer than usual, the delicate membranes round it are tough and hard, the arteries inside it are hard and brittle and are very apt to burst. These changes cause insanity, epilepsy, and apoplexy—diseases that are incurable and often rapidly fatal. The nerves undergo chronic inflammatory changes, which cause much pain and lead on to paralysis.

Thus alcohol has at first a weakening (or narcotic) effect on the nervous system ; but gradually it brings about destructive changes which ruin the health of body and mind. Besides, it destroys the social position of the man, and affects the happiness of his friends. He may be reduced to poverty and misery ; his character lost, and his prospects ruined ; he may commit cruel and brutal crimes while intoxicated. "Nine tenths of all crimes of violence are due to alcohol." "Eighty per cent. of the inmates of work-houses become paupers through drink."

QUOTATIONS:

The great fact to remember about alcohol is its lowering the function of the nervous system. After a time it causes degeneration of the nerve centres, and produces a general paralysis. . . . . The consensus of all observers is that alcohol markedly deprives the nervous system of its force.—*Sir Samuel Wilks.*

The action of alcohol is one of progressive paralysis, affecting the highest powers of the mind first, and reducing the man first to the condition of a child, and afterwards not only to, but even below, that of a beast.—*Sir Lauder Brunton.*

Alcohol has first of all an *indirect* effect ; by its effect on the circulation it supplies the brain and spinal cord with more blood, and so increases their activity ; it acts, however, *directly* on the nerve-cells as a functional poison. —*Dr Rolleston.*

I should fail in my duty if seeing more of the terrible effects of excessive alcoholic drinking in destroying honour and reason and self-control, than almost any one in Scotland, I did not strongly draw attention to a fact so disgraceful to us as a community. [In a quarter of the whole admissions drink was assigned as the sole or a contributory part of the disease.] It is certain that for every man in whom excessive drinking caused absolute insanity there are twenty in whom it injured the brain, blunted the moral sense and lessened the capacity for work in lesser degrees.—*Dr Clouston*, Report for 1900.

QUESTIONS:

1. What are the three great divisions of the nervous system?
2. Where does the brain lie?
3. What are its chief purposes?
4. Give four rules for brain work.
5. What are the consequences of excessive brain work?
6. Where does the spinal cord lie?
7. What purpose does it serve?
8. Name two kinds of nerves. What do they do?
9. Describe the effect of alcohol on the brain.
10. What changes occur in the brain and nerves of the habitual drinker?
11. What percentage of cases of insanity, poverty, and crime are due to the effects of strong drink?

CHAPTER IX.

THE RULES OF HEALTH.

The Rules—the Result of Obeying them. General Action of Alcohol on a Man—on a Child. Conclusion.

Summary.

Eat wholesome food.
Drink pure water.
Breathe fresh air.
Keep the skin clean.
Wear warm clothing.
Take regular exercise.
Sleep soundly at night.

By these means the blood is kept pure and rich in nourishment; the heart strong and vigorous; the skin clean and warm; the muscles powerful; and the brain active. The appetite is keen and digestion easy. The body is well nourished, and the waste matters are thoroughly removed. In short, the man enjoys perfect health, and can do his work with pleasure and satisfaction.

Now, contrast the effect of alcoholic liquors on the body. "The stomach becomes unable properly to digest food; the brain becomes enfeebled; the liver and kidneys become unable to perform their necessary functions; and the heart and blood-vessels become

unfitted to circulate the blood as a result of disease in each of these organs, directly caused by the habitual use of alcoholic stimulants in excessive quantities, and even in quantities which many persons would not regard as excessive."—*Professor Fraser.*

On the growing body the effect of alcohol is still more marked. "When alcohol is given to young animals it stops growth; when given to children, with an idea of increasing vital force, it never seems to promote growth; on the contrary, children seem injured by it."—*Dr Parkes.*

"Stimulants are especially injurious to young persons. Their frequent use is undoubtedly prejudicial to their physical development."—*Professor Fraser.*

From these facts the conclusion is irresistible:—A healthy child does not require alcoholic liquors; during serious illness they may be of service, but at other times they are useless and often injurious.

QUOTATIONS:

Excess in alcohol diminishes the strength both physical and moral, of the individual, and tends to shorten his life, to induce insanity, to lead him into poverty and crime; and the mischief he has done to himself he transmits to his children.—*Sir Lauder Brunton.*

No man can say when he has passed the boundary which divides safety from harm; he may call himself temperate, and yet be daily taking a little more than his system can bear, and be gradually causing some tissue to undergo slow degeneration.—*Professor Parkes.*

Those who suffer from these organic deteriorations of the governing organ of the circulation of the blood learn the fact so insidiously, it hardly breaks upon them until the mischief is far advanced.—*Sir B. W. Richardson.*

A very large number of people in society are dying day by day poisoned by alcoholic drinks without knowing it, without being supposed to be poisoned by them. I hardly know any more potent source of disease.—*Sir William Gull.*

Alcohol causes mental processes to be slower, but gives the idea that they are really faster. This explains how it is that people often continue to use alcohol when those around them see that it is doing them harm.—*Professor Cosgrave.*

Continuous indulgence seems to rob the body of the power of perceiving the injury which the alcohol is inflicting upon the stomach, and other parts of the organism. The warnings of danger, which pain ought to give, are no longer perceived ; and the individual pursues his deluded course in fancied safety.—*Sir Lauder Brunton.*

QUESTIONS

1. Give the seven rules of health.
2. Explain why each is necessary.
3. What results may be expected when these are regularly obeyed ?
4. Describe the effect of alcohol on the various organs of the body.
5. Why are alcoholic liquors specially injurious to children ?
6. What is meant by the *insidious* action of alcohol on the body ?
7. Give examples in the case of the stomach, heart, and brain.

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GENERAL INDEX.

INDEX OF QUOTATIONS.