The mischief of bad air.

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THE MISCHIEF OF BAD AIR.

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THE MISCHIEF OF BAD AIR:

OR

WHAT "BAD AIR" REALLY IS.

Mrs. A. I was glad to see you at our (Sanitary) lecture yesterday evening, Mrs. Brown; I hope you were pleased with what you heard.

Mrs. B. Well, of course, Ma'am, a great deal of it was very true. It's certain we don't all keep our places as nice as we might; and I always say it looks much better to see a place look tidy, and the children's hands and faces clean; but I can't say I go along with all that the gentleman said, neither.

Mrs. A. How so, Mrs. Brown? What was it he said, that you do not agree with?

Mrs. B. Why, Ma'am, I do think he made too much fuss about what he called "bad air." I don't understand all their long words about what the air is made of; but of course they that are clever enough to find out what it is made of, may find out that there is sometimes less of one thing in it, and more of another, and that this may be what makes it smell bad; and to be sure I know bad smells are not pleasant. But then, when he talked of the bad air being *poison* to us, and causing most of the fevers and sickness, why you know, Ma'am, that's more than I *can* believe; there seems no sense in it.

Mrs. A. I daresay it does seem very strange to you, Mrs. Brown; but if you understood a little more how the bad air poisons people, I think you would agree with me that the lecturer could hardly say too much about the mischief it causes.

Mrs. B. Well, to be sure, Ma'am, if it really *did* poison people, nobody would like to be poisoned if they could help it.

Mrs. A. I think, perhaps, I can partly explain to you in what way the bad air really

does poison us. In the first place, I daresay you hardly understand what the bad or impure air the lecturer spoke of actually is. Bad air is nothing in the world but *dirty* air—*foul* air, as it is often called.

Mrs. B. Dirty air! what a funny idea! How can the air get dirty?

Mrs. A. Exactly as everything else does, by being used. The air which you use, by breathing it in, comes out again dirty, as surely as that piece of wet flannel did, out of the inside of the cupboard you were just now cleaning with it.

Mrs. B. Dear now! how strange! Do we breathe the air, then, to clean ourselves inside, as I was cleaning the cupboard?

Mrs. A. That is one of the great uses of breathing. The air, if pure and good when we breathe it in, supplies our lungs, and by means of them our whole bodies, with a sort of food which is most necessary to our health and life, though we cannot see it; and when we breathe it out again, should carry away with it matters which our bodies have no further use for, and which, if they remain in our blood, clog and

literally soil it and the delicate organs and vessels within us, just as what you call dirt does your cupboard, or your brooms, or the skin outside your body. The blood in our lungs, before it is purified by the air we breathe into them, is literally *dirty*, black blood; but afterwards, if we are breathing good fresh, *clean* air, it becomes bright, red, *clean* blood again, fit to refresh and feed our whole bodies.

Mrs. B. Does it indeed, Ma'am? That sounds very wonderful.

Mrs. A. It is very wonderful. The Bible says quite truly that we are "fearfully and wonderfully made." You can understand now that air that has been breathed into our lungs comes out again dirty, as I tell you; and in the same way, whenever the air comes to us over dunghills, or open drains, or rotten vegetables, or foul water, or such like, it carries with it putrid matters and particles from these, and becomes unwholesome, foul air. These unwholesome particles are so small indeed, that we cannot *see* them; but God has given us another sense by which we can find them out. We can *smell* them immediately.

Mrs. B. Then do you mean, Ma'am, that whenever we smell a bad smell in the air, there is some sort of dirt in it?

Mrs. A. Exactly so; and when we breathe this bad-smelling air into our lungs, instead of cleansing, we are positively dirtying ourselves inside, as you would do your basin or saucepan if you were to wipe them out with that dirty flannel just after cleaning the cupboard with it.

Mrs. B. And then that poisons us?

Mrs. A. It poisons our blood. You must not suppose that poison always kills people directly. Everything is really a poison which helps to cause death, whether slowly by disease, or quickly by convulsions as some violent poisons do. And the way in which this foul air poisons us I can a little explain by comparing our lungs, with which we breathe, to a fine sieve through which the waste and all unwholesome matters from the blood are to be sifted out, and at the same time pure clean air-food is to be sifted in. Now, if we breathe air already loaded with such unwholesome matters, it helps to choke up the tiny holes in the sieve, so that not only the waste from the

the air is really *dirty*, and pouring dirt into your children's lungs at every breath they draw.

Mrs. Brown. No fear I shall forget that now, Ma'am, and many thanks to you for making it out plain to me. I always was a clean body, and have no notion of dirt about anywhere, much less in our insides, now I know what puts it there.

THE END.

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THE ADVANTAGE OF WARM CLOTHING.

THERE are men, called chemists, who know a great deal concerning the nature of different kinds of substances, and who, in consequence of this knowledge, are able to bring about very surprising changes and effects. These men have places, termed laboratories, or labour shops, in which they work, and which are divided into distinct chambers, besides being furnished with all sorts of instruments and vessels. Sometimes liquids are put into these chambers and vessels, and there turned into solids. Sometimes both liquids and solids are converted into invisible air. Sometimes beautiful crystals, white and blue, green and red, are brought out of transparent and colourless fluids. Sometimes a few grains of dusty-looking powder are made to vanish into smoke with an explosion that shakes the ground for yards; and sometimes waste rubbish is transformed into delicious scents, resembling those which are produced from the violet and the rose. Even dull, black charcoal has been changed into the sparkling and precious diamond. It would require a very large book merely to number the wonderful feats these men of science are able to perform. Chemists, indeed, in the present day can do much more by their knowledge and skill, than magicians pretended they could accomplish in the olden time.

Chemists make use of many very powerful agents in their laboratories, to aid them in carrying out their objects and plans. Among these agents there are two that stand before all the rest both in strength

and in general usefulness. These prime assistants of the chemists are FIRE and WATER. The *water* is employed to dissolve substances whose little particles it is desired to bring closely together. When two different liquids thus formed are mixed, all the particles in the two come together and act upon one another. Fire is used to soften substances, and loosen the hold of their little particles upon each other, so that they may afterwards be readily mixed together. Water *dissolves* bodies; that is, makes them liquid by uniting them with itself. Fire *melts* bodies; that is, makes them liquid without the aid of water.

Now there is one object which the chemists often have in view, when they put different kinds of substances together, in a dissolved or liquid state, in the chambers and vessels of their laboratories; that is, to get something out of those substances, which was before hidden away in them, in order that they may turn that something to practical use. Thus the chemist mixes together saltpetre, sulphur, and charcoal in the right proportions to make gunpowder. Then having rammed a charge of the gunpowder down into the tube of a gun, with a bullet on the top of a charge, he applies a spark to the gunpowder, and makes it change into smoke and vapour. Something which was hidden away in the gunpowder ceases to be concealed when it is changed into smoke and vapour, and becomes active enough to be able to drive the bullet out of the muzzle of the gun with a force that carries it through the air for a mile, and perhaps then buries it deep in the ground, or in a plank of wood. This is an instance of the way in which chemists *produce motion*, by changing the state and condition of material substance.

I had occasion the other day to watch a still more interesting example of this strange result of the chemist's skill. In a chemist's laboratory, prepared for a particular service, I saw several small chambers of metal, half copper and half zinc, into which were

poured blue vitriol in water, and an acid, a partition wall of pipe-clay standing between. The dilute acid and the zinc were slowly turning into white vitriol, which remained dissolved away in the water; but out of this new-made white vitriol there flowed a power, which was conveyed along a wire, and which made a needle, hung up on a pivot before me, twitch from side to side, almost as if it had been a living thing. I was told that this power set free in the solution, in consequence of the changes brought about there, would run along the wire to the distance of a hundred, or even of a thousand miles, and would there make another needle work and twitch in the same way. In short, I was looking at the electric telegraph at work, and learning that the agent which made the signal afar, was simply a power that had been hidden away in the different substances the chemist put together in the metal chambers, and that was set free and enabled to operate in the production of independent motion, so soon as those substances acted upon one another, and altered the form and state in which each was existing.

Now, my good friend, your living body, and my own, are laboratories, in which changes of precisely the same kind are constantly brought about; your living body, and my own, are made of an enormous quantity of separate chambers and vessels, very small it is true, but nevertheless such as can be seen quite distinctly when they are looked for with the microscope. In these small chambers and vessels different kinds of substances are thrown together, exactly as the zinc, and acid, and blue vitriol are in the laboratory-chambers of the electric telegraph. The chambers and vessels of the living laboratory lie between meshes of the supply-pipes of the body, and it is indeed their minute cavities which are drenched by the circulating streams of the dissolved food, (*see* "*Value of Good Food*," *page* 10) and in which that dissolved food gets to be transformed into flesh and fat, gristle and

bone, tendons and skin, fibres and nerves. The blood, which is pumped forth with such vigour from the heart, creeps along slowly through the smallest and furthest branches of the supply-pipes, in order that plenty of time may be given for all these changes to be worked out in the chambers of the frame. But the fibres and skin, the flesh and the nerves, when they have been built up, are also changed into waste substance by admixture with yet other ingredients which the blood brings to the little chambers. In the cavities of the living laboratory as in those of the electric telegraph, these changes of substance lead to the setting free of agents before concealed, which agents then operate in the production of movements and of other living effects. When I now raise my arm up above my head, I am able to do so because some of the flesh of which my arm is composed, is changed into another kind of substance, the moving power being set free during the change. When I feel this hard stone which I take up in my hand, I am able to do so because some of the substance of which my body is made, is changed into another kind of material at the instant that I feel. This then is how STRENGTH COMES OUT OF FOOD. The food is changed into flesh, and the flesh is converted into two distinct parts, waste substance and moving and living power. The power was originally concealed in the food, placed there by the Provident hand of the Divine Author of Nature, in order that it might be forthcoming for this useful service when it was required. In simple words, material substance is destroyed in order that power may be extracted from it. Material substance, in living bodies, is turned into power. This is the mechanism by which God works in these, the most wonderful of the productions of His hands.

It will hardly be necessary, after all that has been already said elsewhere, to point out that the prime assistant of the chemist, WATER, acts in the living laboratory

exactly as it does in the artificial ones. It loosens, dissolves, and mingles together the various substances which are to act upon one another. It is in the dissolved food, and the liquid blood, which flow into all the chambers and vessels of the living body, and which build up in them the fibres of living structure, and then transform and destroy those fibres, in order that the power there stored away may be obtained.

But it is still more remarkable that the other prime assistant of the chemist, FIRE, should also be employed in the living frame, in loosening its particles, and in quickening the operation of the various changes of substance upon which the production of power depends. It has been shown that in the body of a full-grown man there is as much heat produced in a single day, as would serve to make 80 pints of cold water boil, and it has also been stated that this heat is produced in the body, exactly in the same way heat is produced in the steam engine; that is, by the burning of fuel. The heat is set free by the change of condition in material substance, precisely as power is procured. When the water employed in a steam engine is made to boil, the heat that causes the boiling issues from the coal, because that substance ceases to be coal, and turns into smoke and vapour. Just so the fuel-substance of the body ceases to be fuel-substance—starch, sugar, and fat—and turns into vapour which is steamed away, leaving the heat which was concealed in the substance to warm the frame.

The furnace which is kept burning in the living laboratory, to quicken all the operations which are being carried forward in it, and to exalt its strength, is a slow and gentle one. It never burns quickly enough to cause light and flame, as common fires do. The body is never even raised to the heat of boiling water, which is far less than that of burning coal. It is only made of blood-heat; that is, 68 degrees of the heat-scale warmer than freezing water,—in its warmest parts. Boiling water is 180 degrees of the

same heat-scale warmer than freezing water. The furnace of the living body sometimes burns a little more quickly than it ought, then the body gets warmed into fever. Occasionally it burns considerably less quickly than it ought, then the body is chilled, and its living actions and powers are slothful and languid. Upon the whole, however, its heat is steadily kept up at pretty much what it ought to be, that is at one hundred degrees of the scale, which gives 32 degrees for frost.

Now this is how the furnace of the living body is kept smouldering on in its gentle and even way. Little blasts of air are constantly puffed in upon the burning fuel. That out-and-in play of your chest as you breathe,—that is the puffing of air blasts into certain chambers of your living laboratory, to keep up its smouldering fires. The more quickly and deeply you breathe, the warmer your body becomes; and the more slowly and softly you breathe, the colder that body remains. The same action which blows a fresh wind through the living frame to clear away its impure vapours, also serves to fan its hidden flames, and keep its fuel burning. When the breathing is stopped the fires of the body go out, just as those in a common furnace do, when their air-blasts are arrested, and the body becomes dead cold.

You will remember that when the fresh air is drawn into your lungs as you breathe, it enters a large quantity of little cavities or chambers, which have, all of them, a fine network of the supply-pipes stretched out upon their walls (*see page* 15 *of* "*The Worth of Fresh Air*"); and that as the blood rushes on in its course through these supply-pipes, it sucks air into itself from the air-cavities, and carries it, in its own streams, to all parts of the living structure. Air goes with the blood to that strong force-pump, the heart, and is then pumped out with the blood to every crevice and fibre of the body. Every part of the body therefore receives, by means of the supply-

pipes and in the blood, heat-fanning air, as well as supporting food.

When air reaches the living flesh and nerves, by thus flowing to them in the blood-streams of the supply-pipes, it sets up those changes of substance in their structures which lead to the production of movement, and feeling, and other kinds of living power. When it reaches the dissolved fuel, contained in the blood and in the various little furnace-chambers of the laboratory, it sets up those changes in the fuel which lead to the production of warmth. The fuel is slowly burned in the blood and in the chambers of the frame, and there gives out warmth, as a fire does whilst it is burning in a grate. This warmth consequently heats the blood, and the warm blood carries its heat wherever it goes. The entire body thus becomes as warm as the blood, or nearly so.

Now where do you think all the heat originally comes from, that is procured from burning fuel? The heat is stored away in the fuel, as one of the ingredients of its composition, until it is burned. But where was the heat obtained from, which is stored up in the fuel? Of course, when the fuel was made, that heat-store had to be supplied to it, as well as its other ingredients. First let us see when and how the fuel was made, and perhaps we shall then be able more perfectly to understand this matter of its warming qualities and power.

In the case of coal, it is not a very difficult task to trace the stored-up heat to its source. But what a surprizing truth it is, which becomes apparent when the task has been performed. The heat is, so to speak, *bottled-up sunshine!* Coal is dug up from deep mines hollowed out in the earth. But at one time it was wood, growing on the outer surface of the globe, and covered with foliage which was spread out into the genial air. Traces of the leaves and stems from which it has been made, are still discovered in its substance. Long centuries ago, the vast forests

containing these trees, were overthrown by some tremendous earthquake, and swept away by strong floods of water, and so the tree-stems were at last deposited in hollow basins, and were there buried up by millions and millions of tons of heavy rock and soil. There, where they were buried, they have remained, turning more and more black and dense through the process of slow decay, until they have been dug up piece-meal to feed the furnaces and fires of the existing generation of men.

Now you know very well that trees only grow in warm weather, and in sunshine. In winter time their branches stick out stiff and bare, and do not increase in the slightest degree. But in summer time they clothe themselves with beautiful masses of foliage, and suck in from both the air and the soil large quantities of vapour, of liquid food, and of sunshine. All these they combine together into fresh layers of timber. All these therefore were buried in the ground as timber, when those old forests were overthrown which form the coal-beds. Timber cannot be made in *cold* weather, because *heat* is one of its necessary ingredients. But as all the warmth of the weather comes from the sun, it is *the sun's warmth which is stored away in coal*, and which is set free and made useful when the coal is burned.

The grand source of all warmth on the earth is that brilliant light which God has placed in the sky to rule over the day. In a summer's day you sit down in the bright sunshine, and bask in its warmth. In winter time, when the sky is covered with clouds, and ice and snow lie thick over the ground, you place yourself indoors near the glowing fire; but strange to say, it is still the sun's genial warmth that you experience. If the fire be of coal, it is warmth which was borrowed from the sun centuries ago. Reflect for an instant upon this marvellous arrangement entered upon, for your comfort, ages before you were yourself called into being! When those coal-making forests

spread their broad masses of foliage out in the sunshine, there were no human creatures existing upon the earth; and, indeed, not even the flocks and herds, which are so essential to man's welfare, had been framed. Neither cattle nor sheep could have found pasture on the plains which yielded them support. The great duty of those forests must have been to store up genial warmth for then uncreated generations of beings, who in due season were to appear, and to avail themselves of the provision thus made.

But suppose that you had neither fresh nor stored-up sunshine to fall back upon, and had to depend entirely for your warmth upon that furnace which is carried about in your living laboratory, and kept alight by the puffing of your breath. Still that internal heat comes originally out of the sunshine. Just before the time when man was placed upon the earth, the beautiful family of plants was created, which fills the gardens with roses, and which yields the apple, the pear, the cherry, the plum, the apricot, the peach, the almond, the strawberry, and the raspberry. Just at the very time was planted on the globe, the vegetable tribe which furnishes the different kinds of nourishing grain, and which provides pasture for grazing animals. The fruits, the grasses, and the grain were all commissioned to extract power and warmth from the sunshine, and to store it up in such a form that the influences could conveniently be introduced into the interior of the living body. Living animals which are warmed by the fuel contained in their food, procure their heat from sunshine that was stored up, as it were, but yesterday. When animals live upon flesh, and get their strength out of the lean fibre, and their warmth out of the fat of this food, still it must be remembered that the flesh has been fed on the grass of the field just before. The main office of the plant in creation is thus to store up in a fixed and convenient form supplies of active energies which can be turned to account by animated

frames. The plant effects this end by preparing the food upon which animals live;—that food which, besides keeping the body in repair, serves also *to furnish it with warmth*, and *to give it strength and power*. (*See page* 7, "*Value of Good Food.*") How admirable and beneficent is this plan, whereby the genial influence of life-quickening sunshine is economized and preserved for the service of one-half of creation, by the instrumentality of the other half!

In the far distant regions of the north, there are places on the earth to which no daylight or sunshine comes for four long months at a time. During this gloomy period the ground goes on, from hour to hour, scattering more and more of its heat, until it is almost as cold as the chill space in which the great world is hung, and has indeed more than 100 degrees of frost. The land and the water alike get covered up by one broad and thick sheet of never-melting ice and snow. There is not a leaf, or a grass-blade, or a vegetable stalk any where in the wide white desolation. But there are animals, and human beings, who are born and die, and who maintain a prolonged existence in it. Let us just look in upon one of the households in this drear frost land, and see what the odd community is like.

In the midst of a broad snow-waste, through which the sharp wind is howling with a fearful sound, there is a small mound nearly covered by the snow-drift. We perceive this mound by faint star-light, the only gleam that comes down from the sky. A few feet away from the mound we discover a small hole blocked up by a lump of snow. We move the lump aside, and stretching ourselves out at full length on the ground, we squeeze into the hole head foremost, and crawl along a narrow passage, burrowed out in the firm snow for about a dozen feet. We then find ourselves in a vault 10 feet wide and 15 feet long, and so low that we can scarcely sit upright within it. This is the inside of the mound. It is the interior of

a hut or dwelling-place of these people of the drear frost-land. The walls of the hut are built of large stones piled together, with a padding of frozen moss covered over them, and with thick ice and snow covered over the moss.

There are 12 living individuals, men, women, and children, huddled together in this close vault. They have no fire to keep them warm. Indeed there is neither coal nor wood, which they could use to light a fire, within many hundred miles. There is in one corner of the hut a broad shoulder-blade of a large quadruped laid flat, and in the hollow of this blade there is some crushed seal's blubber, and some soft moss, with long cotton-like rootlets. The end of the moss is burning with a small, dull, smoky flame. This is the only artificial source of light and warmth within the hut.

But these people are all of them almost entirely naked; and they are dripping with perspiration, they are so warm. Outside of the hut, in the dim star-light, the air is actually a hundred degrees colder than freezing water. Yet inside, in the nearly as dim lamp-light, there are almost as many degrees of warmth. The air is there as hot as the hottest summer day in England! All this heat is produced in the slow furnaces of those twelve individuals' own living bodies. They have lost the sunshine for months, and everything around them is much colder than ice. They are living upon the flesh and blubber of seals, and sea-horses and white bears, animals which they killed before the sun went away, the meat being kept for them through their long winter by the preserving power of the frost. The sunshine of past-away summers has given its heat to plants; the seals and sea-horses have fed on those plants, or upon smaller animals which have done so, and have transferred the heat into their own blubber; and now the benighted savages are getting the heat out of the blubber to keep their own flesh and blood warm and

unfrozen. In that close hut, where no sunshine can come for months, the savage inmates have nevertheless abundant stores of the warmth of sunshine, which have been laid up and preserved for their service. Such care Providence takes even of these, the rude and barbarous children, whose lot He has cast in the desolate outskirts of the world!

The rude people who dwell in the cold frost-land of the north, remain warm through their long severe winter, without the aid of artificial fires, because they economize the warmth which is produced in the slow furnaces of their bodies, and prevent it from being scattered away as quickly as it is generated. If they were to sit themselves down in the open air, instead of in their close huts, the warmth produced in their bodies, would be thrown off from the outer surfaces of these as fast as it was set free from the fuel. In the close huts, on the other hand, this warmth first heats the air contained within the stone walls, and is then a very long time in getting any further, and so prevents more heat from being rapidly scattered from the internal furnace.

These human inhabitants of the Northern Ice Land have a companion in their desolate haunts, who does not build himself a hut after their fashion, but who has instead a somewhat similar protection against the severe cold of the long northern winter, provided by nature. This creature goes upon four legs, sometimes swimming in the water, and sometimes stalking along upon the ice. He is very powerful and fierce, is armed with sharp claws two inches long, and has teeth which can bite through iron bars half an inch thick. He is able to tear iron and tin to pieces as if they were merely paper or pasteboard, and he feeds upon seals, birds, foxes and deer, which he manages to catch by his cunning and address. This savage creature is often killed by the rude natives, who hunt him with dogs and spears, but in the absence of man he is the fell tyrant of the domain. He prowls about

on the snow-wastes, destroying every living body which comes within his reach; and he remains exposed to the severest cold of the long dark winter, lying upon the ice and snow, without having his life-blood frozen by its chill power. The reason of his safety is that he wears a nature-provided great coat of very warm fur. His skin is every where covered by long shaggy hair of a yellowish-white colour, which has a thick down-like under-growth closely packed beneath. This coat of soft fur is so long and thick, that it prevents the heat produced in the slow furnace of his body from escaping into the cold air. It answers the same purpose to him, that the snow-covered hut does to his human neighbours.

Men have no warm shaggy coats of this kind furnished for their use by nature, but they are enabled to supply the deficiency through the exertion of their own intelligence and ingenuity. They borrow warm coverings from other creatures whenever they stand in need of such aid. Thus the rude human inhabitant of the Ice Land hunts and kills the bear, and then before he feasts upon its flesh, he strips the fur robe from the carcass, and adapts it to his own naked body. So soon as the northern ice-people come out from their huts into the cold air, they put on coats and trousers of bear-skin, with the long sharp claws pointing out as toes to their boots. These odd savages look almost like small bears themselves when their white fur hoods are drawn down over their heads, and their limbs are compactly muffled up in the claw-tipped robes which they have taken from the bodies of their prey.

Men in civilized lands do not put the *skins* of other animals upon their own bodies, but they do what is precisely the same thing in effect. They borrow silk from the worm, or cotton from the grass, or flax from the linen-plant, or wool from the sheep, and by their constructive skill, they spin and weave these substances into cloths, which are much more

convenient than raw skins for the fabrication of garments, and which can be made as warm, when this is required. In every case, however, this artificial clothing acts in the same way as natural fur. It is warm, because it prevents the heat, which is produced in the slow furnace within the body from escaping quickly from the little chambers of the living laboratory. Clothing does not really warm the body, it merely *keeps it warm;* prevents it from being cooled as it would be if this covering were not placed between its surface and the outer air.

Warm bodies constantly grow colder, when situated in spaces which are more chill than themselves, provided always that there be no furnaces, quick or slow, within them, for generating new supplies of heat. They do so, because they give the excess of heat which they contain to the neighbouring space, in the attempt to make it as warm as themselves. Warm bodies are always very generous, and disinclined to keep what substances near to them are less freely supplied with. If a metallic pint pot, filled with boiling water, be placed on the ground in air which has only the warmth of a March English day—some fifty degrees of the heat scale,—the water gets colder minute by minute until it remains no warmer than the air and ground which are around it. The rapidity with which warm bodies are cooled depends upon how much colder than themselves the space around them is. If one pint pot of boiling water be placed in out-of-door air that is cold as freezing water, and another be placed at the same time in a room where the air has the warmth of a mild summer day, the former will be deprived of all its excess of heat much sooner than the latter.

Warm bodies lose their excess of heat in two ways. They *shoot* it off into surrounding space. This is what learned men call "*raying*" or "radiating" it away. The sun, you know, shoots or rays its heat off to the earth, and so does the fire to your body

when you stand before it. But warm bodies also communicate their heat to substances which touch them, provided those substances be colder than themselves. Place your hand upon a cold metal knob, and you will feel that your hand grows colder as it gives portions of its heat to the knob. This is what learned men call "*conveying*" heat.

Now the clear transparent air permits heat to be shot off, or rayed through it with great freedom. But it does not readily receive heat "by conveyance," so long as it is still. If you put your hand into still air which is as cold as a cold metal knob, you do not know that the air is so chill as the metal because it does not make your hand so cold. The heat is not conveyed away from your hand as quickly. When air is *moving*, instead of being still, the case is, however, altogether altered. A current of air, or wind, carries away heat from warm bodies very quickly as it blows over them. It does so, because each fresh little particle of air which is pressed against them, receives its own share of the heat, and conveys it away, leaving fresh particles to come up in their turn, and do the same thing. A pint of boiling water in a metal pot placed in a strong wind having 50 degrees of heat, would lose all its excess of heat as soon again, as it would if standing in still air having the same warmth. The old plan of cooling hot tea or broth by blowing it, is correct in principle though not in accordance with good taste.

The laboratory of the living animal body, has the supply of its fuel, and the capacity of its air-blasts, so arranged, that just about as much heat is supplied through its internal furnace, as is lost from its surface by "raying off" and "conveyance," when the surrounding air has a warmth of 60 degrees of the heat scale, and when its surface is somewhat protected by a light covering of clothing, to lessen the rapidity with which the heat is shot off and conveyed away. The heat is then produced as rapidly in the internal

furnace, as it is thrown off from the outer surface, and the consequence is that the animal *feels comfortably warm*. It only feels uncomfortably *hot*, when more heat is produced in the furnace of the living laboratory than can be scattered through its surface. And it only feels uncomfortably *cold* when more heat is scattered from the surface than can be kept up through the burning of the inner furnace.

But in winter time the cold external air carries away heat much more quickly from the surface of living animals, than the warmer external air does in summer time. Here then is a little difficulty to be met, if the warmth of the body is to be kept precisely the same in both seasons. It is requisite that it should be always maintained at the same point, because that point is the one which is most suitable for the operations which are being carried on in the vessels and chambers of its laboratory. Nature has two distinct ways in which she insures this end.

In the first place, are you not aware that you get more hungry in winter than you do in summer time? All living animals have pretty much the same experience as yourself in this particular, and the reason is that Nature intends, during the cold season, to have more fuel introduced into the supply-pipes of the body for the warming of its structures. The furnace of the laboratory gets quickened in a small degree;—its slow fires are fanned into slightly increased activity, more fuel is burned, and so more heat is generated to meet the greater demand for it, dependent on the influence of the external cold.

But nature also thickens the clothing of animals during the cold season, and so affords increased obstruction, through which the escaping heat has to force its way. Have you not observed the sleek silky coat which the horse wears through the summer in our English climate, and then noticed at the beginning of winter how this sleek coat is exchanged for a thick, fuzzy shag, that looks more like wool than

hair? The warm winter coat economizes the heat, produced in the furnace of the living body, and keeps it from being scattered to waste as quickly as it is through the sleek summer coat. This is nature's other plan of meeting the difficulty brought about by the changing temperature of the air. Nearly all animals belonging to temperate and cold climates, have this change of apparel provided for them in spring and autumn, but in some cases the change is rendered very striking in consequence of a summer garment of bright gay colours being replaced by a winter one of pure and spotless white. The fierce tyrant of the Ice Land himself, the Polar Bear, has a dingy yellow coat during the summer, but puts on furs as snowy as his own realms when once the summer sun has disappeared. These white winter furs are always warmer than dark ones. Birds which do not migrate to warmer regions of the earth in the cold season, have winter and summer suits of apparel, just in the same way as quadrupeds. In the winter a lining of thick soft white down is added beneath the outer feathers. There is one little bird which comes to England in the late autumn, driven there by the still greater cold further north, and which is familiarly known as having two remarkably different costumes for his English and his foreign residence. In England the snow-bunting appears with a white body and tail, but abroad and in summer time he is distinguished by a brilliant black tail and back, and a body and head of pure white.

Man follows the example which nature has set before him, in the matter of clothing. He prepares himself stout warm garments for winter-time, and thin cool ones for the summer; and not only this; in the hottest regions of the earth, where there is most sunshine, he commonly goes nearly naked, while in the coldest regions, near the poles, he puts on the heaviest and warmest woollens and furs that he can procure. Now this is one reason why man has been *apparently* so un-

cared for by nature in the particular of clothing. The seeming indifference and carelessness is really consideration of the highest kind. All the different races of the lower animals have their own narrow tracts assigned them for their residence. In these tracts there is no very extreme diversity of temperature; and provision is therefore easily made to adapt their clothing to it just so far as is required. The human race, on the other hand, is intended to cover the entire earth, and to subdue it; to spread itself from the burning tropics to the frigid poles. The heat which has to be borne in the tropics, is as much greater than that which is experienced near the poles in winter-time, as boiling water is hotter than ice. At the poles, 100 degrees of frost often occur. In India, there are occasionally 130 degrees of heat under the canvass of tents. It therefore becomes an affair of almost absolute necessity, that the skin of the widely scattered lords of the creation, should be as unencumbered as possible, and that warm clothing should have to be prepared and added as a covering whenever circumstances call for its use. The head only, of the human being, has a natural fur garment. This part of the body is covered with hair, because the most delicate portion of the entire frame, the brain, is contained within it. The skull is protected by hair, that the brain may not be hurt by too sudden a change fron cold to heat, or from heat to cold.

There is another advantage attending upon the arrangement which has left human beings dependent upon an artificial supply of clothing, and which has ordained that they shall come into the world with naked skins. In consequence of this arrangement, it is very easy to secure that amount of cleanliness which is necessary for the preservation of the health of such delicately framed creatures. The artificial clothes can be altogether changed at will, and they can be washed and aired, as they never could be if they were inseparably attached to the skin. Then

too, they can be removed from the skin in the early morning, or at convenient intervals, and its surface can be thoroughly cleansed and purified by bathing with water. Just think of the difference of going into a bath of refreshing water unencumbered by clothes, and of doing the same thing with thick, dabby garments clinging about you, and having to shake yourselves like great Newfoundland dogs when you come out; and also recall to mind the pleasure you experience every time you change soiled linen for clean, and you will become sensible how much you owe to beneficent nature for having left you destitute of the feathers of the bird, or the fur of the bear. The extreme importance of making a fair use of this privilege has been already alluded to in its proper place. (*See page* 29 *of* "*The Use of Pure Water.*")

But nature has effected yet another very bountiful provision for the comfort and safety of her tender charge, the living human animal. Even when only covered by very light clothing, it is possible human beings may be placed in air which is so warm, that heat is not carried off from their bodies so fast as it is produced in the interior furnace. In India, it sometimes happens that the air gets to be even hotter than the living body. All movement of the air then, heats, rather than cools. Under such circumstances, nature adopts a very effectual course to prevent warmth from collecting more and more in the frame, until a disagreeable and injurious amount has been reached. Having first reduced the supply of fuel to the smallest limits consistent with keeping the fire going, by lessening the appetite, and by taking away the craving for heating food, and having given a hint to adopt such outer coverings for the body as are as little obstructive of the passage of heat as possible, the heat drenches the surface of the frame abundantly with moisture, which has the power to cool by its ready evaporation. Take a small piece of wet linen, and lay it upon your forehead, or upon your arm,

leaving it freely exposed to the air, and you will find, that as the moisture evaporates from the linen, your skin underneath will feel colder and colder. The heat of the skin is used up in converting the moisture of the linen into steam, exactly as the heat of a fire is used up in converting the water of a kettle into steam when this is made to boil. The steam flies away with the warmth of the skin very rapidly, and consequently, the skin soon comes to feel cold. Now, when the body gets to be very warm, and the overheated blood is rapidly pouring through the channels of its supply pipes, then the three millions of little holes or pores, which lie upon its surface, are opened, and floods of vapour and water are poured through them producing just the same kind of effect as wet linen would do. (*See page* 25 "*Use of Pure Water.*") This action is termed "*perspiration*," or a "steaming through" the pores of the skin. The breathing blows up, or fans the slow furnace contained within the living animal frame, and so heats it above the surrounding air. The perspiration carries away portions of this heat when it has been raised too high, and so cools the heated body down. Some moisture also escapes as steam from the lungs and through the mouth in breathing, thus assisting the perspiring skin in its office of diminishing the excessive warmth of the body. You have often seen dogs, which have been heated by running, pant with opened mouths and outstretched tongues, the vapour streaming forth from their gaping throats. Dogs cool themselves in this way because they have very little perspiration passing through their skins. Their perspiration is really from their throats, rather than from their skins. Human beings sometimes lose in hot weather, as much as five pints of water during twenty-four hours, by exhalation through the lungs and skin.

Give me now, good reader, your close attention for just a few minutes while I return to the notion with which we started on beginning the consideration of

this subject, so that I may fit it into its right place, and leave it well packed away with the other notions that we have gained, while studying the value and uses of air, water, and food. Your body is a living laboratory, formed of an enormous quantity of little chambers and vessels. From a strong central force-pump, placed in the middle of that laboratory, liquefied food, or blood, is streamed out through branching supply-pipes to the several chambers, to carry to them the materials that have to be operated upon in their cavities for the production of animal power and warmth. The force-pump acts by repeated short strokes, but the liquefied food flows through chambers of the laboratory in continuous, even currents, because the supply-pipes are made of yielding and elastic substance, like India-rubber, and not of hard, stiff substance, like metal or wood. As the liquefied food gushes out from the force-pump, the elastic walls of the supply-pipes are stretched by the gush, but directly afterwards, they shrink back again, as India-rubber would do; shut close a valve that prevents all *return* of the liquid into the force-pump, and so compel the liquid to run onwards in the other direction, through the pipes. Before the shrinking in of the pipes has altogether ended, the force-pump renews its stroke, and so the onward flow of the liquid never stays, although the pump has to make beat after beat. The liquefied food gushes out from the force-pump with a speed of about a foot in each second; but it has to supply such an enormous host of small chambers in the remote parts of the laboratory, that it does not flow through them with a speed greater than an inch in a minute. This, however, is no disadvantage, as it affords plenty of time for the full carrying out of all the intended changes in those chambers, whereby animal power and warmth are to be produced.

Remember, then, that as your heart beats in your chest, second after second, the red blood flushes through every crevice and every fibre of your living

frame, just as it does through your cheek when it is crimsoned with a blush. Seventy or eighty times every minute, your beating heart pumps, and constantly, so long as you are alive, the flushing blood streams on everywhere. The blood, however, streams on in this continuous way, because its flow is *not stopped*, even when it has reached the remotest chambers and fibres. The trunks of the supply-pipes divide into branching twigs, which get very fine indeed where they are in connection with the working chambers of the laboratory, and which then lead on into *return-pipes*, that are gathered together into enlarging trunks. These, in their turn, are collected into main tubes which end in the cavity of the heart. At the extremity of these main trunks of the return-pipes, valves are so placed as to prevent the pumping action of the heart from forcing the blood back into them. Thus, as your heart pumps, swelling out and drawing in its walls, the blood flows into its cavity by the return-pipes, and is squeezed out therefrom through the supply-pipes. It always streams *in one direction*. It *circulates* through the living frame which it flushes; that is, it goes in an endless circle, now through the heart, now through the supply-pipes, now through the return-pipes, and now starts once again through the heart.

But as your blood thus circulates through your living frame, fresh nourishment, newly dissolved food, is added in some places to its streams; in other places nourishment and fuel are taken from it to furnish the active chambers of the laboratory with warmth and power; in other places worn-out substance is added to it to be carried away in its current; and at other places this worn-out substance is poured away from it through the outlets provided for its removal. The principal outlets through which the waste of your living laboratory is poured away, have been already spoken of in detail—they are the pores of the skin; the drains of the laboratory; and the pores of the

lungs, that with the mouth form the chimney of the laboratory through which the smoke and the vapours from the burned fuel, fly away. In addition to these outlets, there is, however, another series by which some denser matters, which cannot be got through either the skin-pores or the lungs, are streamed away. This series is continually in operation, but the details of its arrangements are so ingeniously planned, that it accommodates its work to the demand of each passing instant. When, for instance, the perspiring-pores of the skin are widely opened for the cooling of the frame, and an increased amount of liquid is consequently steamed away through them, then these outlets are narrowed; but when, on the other hand, the skin-pores are closed, or when any extra flood of liquid is thrown into the interior of the frame during cold weather, then these additional outlets at once are brought into very active play.

Now just imagine the case of a large town, in which there is a certain quantity of waste liquid needing to be carried away through drain-pipes every day, but in which also there occur occasional excessive floods of rain, which must have a way of escape provided for them whenever they happen. How clever you would think it if some skilful engineer fixed valves in the drain-pipes of that town, which kept themselves fast closed under ordinary circumstances, but which opened of their own accord whenever the pressure of an extra flood came, and so allowed the excess of liquid to flow safely and freely away. Such has really been the proceeding of the skilful Engineer of your living frame. Your body is exposed to the risk of occasional excessive floods. When the weather is very cold, for instance, the pores of your skin are closed, and not more than a single pint of liquid can force its way out through them, in the place of the four pints which would pass in warm weather. Much of the water which would otherwise have escaped from the channels of the

supply-pipes, then remains in them, coursing round in the progress of the circulation. Sometimes, too, in all probability you will be tempted to swallow an unreasonable quantity of liquid, beyond any demand the mere process of cooling an over-heated frame can require. But whenever you have thus set up an unusual internal flood, sluice-gates are opened, and through these the excess is rapidly poured until the flood is got rid of. In those parts of your body which have been named the kidneys, there are pores through which waste liquid is always draining, without being turned into vapour or steam; but in the kidneys there are also chambers composed of very fine walls, which are strong enough to prevent fluid from passing through them when it is only pressed by a gentle force, but which are not strong enough to do so when the pressure becomes greater in consequence of the over-flooding of the supply-pipes. The kidneys are the sluice-gates of your body, provided with outlets for common use, and with self-acting valves which come into operation upon occasions of excessive flood.

Thus astonishing, then, is the care which has been taken in perfecting the arrangements of the heating-service of that complicated laboratory, your living body. Fuel is thrown into an internal furnace, more or less plentifully, according to need. The fuel is there burned, and fanned by air-blasts, which are strengthened or weakened as the occasion may require. The heat produced by the burning is economised by external packings and wrappings, or it is scattered by the opening of evaporating-pores on the external surface, and by the drenching of that surface with steaming moisture; and self-acting valves are provided to regulate the quantity of liquid contained in the supply-pipes, so that the cooling pores may never be forced into mischievous activity by the mere pressure of excess in their channels, at a time when the body is already sufficiently chill.

When cold is suddenly applied to the previously warm skin of the living body, it shuts up all the perspiring pores at once, and then empties its supply-pipes of their streaming blood *inwards*. You know how pale and numb your skin becomes on a cold frosty day, when you stand quietly in the chilling air. That is because the cold squeezes all the blood out of the small vessels of your skin. But where do you suppose the squeezed-out blood goes to? It flows directly into the several internal parts, choking up and overloading their channels. If the skin be soon made warm again, the overloaded parts of the inside once more get emptied, and recover their usual freedom; but if it be *kept cold*, then their overloading and choking continues, and great discomfort is experienced. All kinds of inflammations and disorders are produced in this way. What are commonly known as colds are internal obstructions of this nature. Cold in the head is an affection in which the lining of the nostrils is overcharged with stagnating blood. Sore throat is caused by a similar condition in the lining of the throat. And cough by the same state in the lining of the vessels and cavities of the chest.

The mere application of a chill temperature to the skin is not alone, however, enough to give a cold. This result chiefly comes when the application has been made while the body is in a weakened or exhausted state, and therefore has not the power to resist and overcome the internal disturbance of the even blood-flow. Colds are nearly always caught in consequence of a sudden exposure of the body to a chill, either when it is in a state of exhaustion and fatigue from sustained exertion, or when it has been for some time previously over-heated. Excess of heat itself soon produces exhaustion, and depression of the strength and the powers of life. When a chill is applied to the skin while the body is fresh and strong, as, for instance, when a man pours cold water over

himself the instant he gets out of a warm bed in the morning, after a sound and refreshing sleep, it does no harm, for this reason;—First, the blood is driven away from the supply-pipes of the skin by the cold, and flows inwards; but the refreshed heart, then becoming sensible of its arrival, rouses itself to increased effort, and prevents obstruction by pumping on the liquid more vigorously. By this means blood is soon sent back again to the skin in great abundance, and makes it *glow* with renewed warmth. It is only when the cold was very severe, or very long continued, that this re-action, as it is called, would be hindered, and internal disorder be likely to be set up.

Here, then, is one of the advantages of employing warm clothing. It prevents the catching of cold by protecting the skin from sudden chills at a time when the internal parts of the frame are depressed and unable to meet, without injury, the effects which follow upon it. If at any time you are very weary, and very warm, remember, then, that you must keep yourself warm by drawing more clothes round you, or by some other plan. Want of attention to this very simple proceeding, or absolute ignorance that it ought to be adopted, is among the common means *whereby men lay up for themselves disease and suffering*, and cause sickness to take the place of health.

How constantly it happens, at the very first appearance of fine weather in spring, that sore throats and coughs and colds are met with everywhere. This is nearly always because people are then tempted to throw aside the warm clothing which they have used through the winter, and so to leave their skins very much more exposed to the influences of the sudden chills, which are quite sure to occur at this time. Just observe what nature herself does in this matter. She does not take off the horse's warm coat the moment the spring sunshine bursts out in the sky. She compels him to keep it upon his back,

at the risk of his being a good deal encumbered by it now and then, because it is better he should submit to this small inconvenience for a time, rather than be exposed to the danger of grave disease. As you may advantageously take a lesson from the bee as to the management of fresh air in your dwellings, so you may advantageously go to the quadruped to learn how to manage the alteration of your clothing at the change of the seasons. When you see the horse putting on his fine silken garment for summer, follow his example; but until you do see this, be wise, and still keep within the protection of your winter wools and furs.

There is another plan by which people every day expose themselves to the danger of catching cold, and of so falling into disease. They commonly sit in very draughty rooms;—apartments which are warmed by bright fires, but which are at the same time chilled by cold wind rushing in at large crannies and crevices, far beyond the quantity which is needed for the mere supply of pure air. Such rooms are warm and cold climates brought together into a nutshell. There is a scorching summer near the fire, and a freezing winter near the window at the same instant. Merely walking about the room therefore takes the body in a moment from one climate to another, and this must happen sometimes when the body is not prepared to meet, and accommodate itself to, the change. A chilled surface, and internal obstructions result, and colds and diseases follow very soon. The inside of rooms should be in winter time very much what they are in the summer season; that is not too hot, but equally warm in all parts, and with a sufficient current of air passing through them to keep them pure, although not with enough to set up dangerous draughts. If there are draughts, then the protection of warm clothing must be constantly employed, to prevent the chilling influence from attacking the skin. The arrangement of the fireplace named at *page* 27 *of*

"*The Worth of Fresh Air*," enables the rooms of dwelling-houses to be kept in a very desirable and healthy state, in this respect. The ventilating valve into the chimney provides for the free removal of the impure air, while the narrowing and closing of the chimney-throat serves to discourage and stop draughts, and to keep the air at a tolerably even warmth everywhere throughout the apartment. Warm and undraughty dwelling-rooms are the natural allies of warm clothes in health-preserving power.

There is another very excellent companion and helper of warm clothes in this good work. This helper is EXERCISE. If when you are weary and warm, and have no additional clothes to draw round you on the instant to prevent a chill, you sit down or stand still in the cold wind, you will be nearly sure to catch cold, and to be made ill. But if, on the other hand, you keep moving about until you can either clothe yourself more warmly, or go into a warm room, then you will be almost as certain to escape without harm. Exercise aids the heart in keeping the blood moving briskly, and if at any time there is an inclination for the blood-flow to stagnate and get obstructed internally, then exercise overcomes the obstruction, and sends the lagging blood cheerily on towards all parts of the frame, and back towards the skin. Brisk exercise thus possesses the power to overcome mischief, as well as to prevent it. (*See page* 16 *of* "*The Worth of Fresh Air*.") Its influence in quickening and sustaining the flow of the blood-streams through the supply-pipes of the body, necessarily leads in the end to the strengthening of every structure in the frame, and to the rousing of every operation that is carried on in the living laboratory. Every one who values the blessing of health and strength will do well, if his daily task is not one of exertion in the open air, to make such a task for himself. One hour at least out of the twenty-four should be spent in quickening the blood-streams, and

in deepening the breathing by walking briskly in some open space where the fresh winds of heaven have free play.

But we will now imagine that in ignorance of all these particulars, or in consequence of some long-continued exertion and exposure which the demands of duty made it altogether impossible for you to avoid, you have caught a cold, and are beginning to suffer from a sore throat, or a cough, or some other sign that matters within are not as they should be. What, under such circumstances, ought you to do to stop the cold, and get rid of it, before serious disorder is brought about? Here, again, warm clothing is of the highest value. If the chilled surface be at once closely covered up, and be kept covered, the blood is soon drawn back to the skin, and the internal obstructions are in this way overcome. The best possible way to get rid of a cold quickly, for those who can follow it, is to go to bed as soon as it begins, and to keep there until the cold is cured. If you cannot follow this plan, then *drink as little of any fluid as you can* for four or five days, and there will soon be not enough blood, as regards quantity, in your body to keep internal parts over-charged, and they will be relieved, and you will get well. There is this evil in the first plan of curing a cold. People who have lain in bed for some time, come out of it with the pores of their skins more than usually opened, and more than usually disposed to suffer from any fresh chill. People who pursue the second plan may be exposed in any way, without meeting this risk.

There are thus then **Golden Rules for the management of the clothing**, as well as for the management of the feeding, which all people should have stamped on their understandings, and engraved upon their memories. These are—

Follow the example which Nature sets, and WEAR THICKER CLOTHING IN COLD WEATHER THAN IN WARM.

DO NOT LAY ASIDE THE WARM CLOTHING OF WINTER, AS SOON AS FINE MILD WEATHER SEEMS TO HAVE BEGUN, but wait until you see that Nature is taking their winter garments away from the birds and the beasts.

NEVER EXPOSE YOURSELF TO A CHILL WITHOUT EXTRA CLOTHING, WHEN YOU ARE WEARY, as well as warm.

NEVER SIT IN DRAUGHTS OF COLD AIR WITHOUT PUTTING ON EXTRA CLOTHING.

KEEP IN BRISK EXERCISE WHEN YOU ARE UNABLE TO AVOID CURRENTS OF CHILL AIR, AND ARE AT THE SAME TIME FATIGUED BY EXERTION, AND THINLY CLAD.

NEVER REMAIN IN DAMP CLOTHES LONGER THAN YOU CAN HELP. Damp clothes chill the surface of the body very rapidly by carrying away its heat as the moisture is turned into steam. Wet stockings and boots, or shoes, are injurious, for the same reason as other kinds of wet clothing. They are not more dangerous than other kinds of damp garments, but they have to be encountered much more frequently on account of the ground often remaining wet for long periods, when there is no great excess of moisture in the air. Wet feet produce harm more frequently than wet clothes, because they are much more common.

By a careful and constant attendance to the principles laid down in these **Golden Rules**, the attacks of many grave diseases may be avoided, and the advantage which is intended to result from the influence of warm clothes, may be most certainly secured.

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