VENTILATION.

The NEWS begins herewith the publication of the full report of a lecture on the above important and much abused subject, delivered by Dr. James E. Talmage to his course of lectures on general chemistry at the Church University. The conclusion of the paper will appear in tomorrow's issue. The lecture was given on the evening of Monday, April 23, before the large evening class, composed of the University laboratory workers, and the general students. The general attention was paid throughout the address, and it is to be hoped that the excellent instruction so imparted will be put to good service in an earnest attempt to correct some of the many flagrant violations of the laws of health, now so common amongst us through the willful and almost criminal disregard of our need for pure air. Dr. Talmage said—

In ordinary usage the term "Ventilation" is applied to any process designed to renew impure air from confined spaces, and to provide for the introduction of pure air in its place. In considering this subject we have to inquire: (1) What is pure air, and wherein lies its indispensable service to the body? (2) By what means and at what rate is the atmosphere generally contaminated? (3) How may the purity of the air of dwellings be maintained?

1. PURE AIR is air in its normal condition, the way in general terms consists of about one-fifth oxygen, a little less than one-fifth oxygen, with very small amounts of carbon dioxide and vapor of water. More accurately speaking, pure air consists of the following, the proportions being by volume:

Nitrogen	79.19 per cent
Oxygen	20.81 "
Carbon dioxide	.04 "
Water vapor, variable amounts	

The presence of each of these ingredients has been demonstrated by conclusive experiments to this class. Oxygen, you will remember, is the universal and vigorous supporter of combustion. To its presence is due the possibility of burning ordinary fuel. Nitrogen is the diluent and, efficient in restraining the action of the fiery oxygen. It may be separated from the oxygen by burning out the latter through the agency of a burning fuel in a bell jar. Carbon dioxide alone will not support combustion. Its introduction in quantity is fatal to life, not because of any specifically poisonous properties in the gas itself, for in its effects it is generally inert, but because of its taking the place of the invigorating oxygen in the lungs. Carbon dioxide is a colorless gas; its presence in the atmosphere may be proved; as has been shown here in experiment, by aspirating a quantity of air through some lime water; the carbon dioxide enters into combination with the lime which is in solution, forming calcium carbonate, and this substance, being insoluble in the water, appears as a white precipitate giving a faint milkiness or a deeper turbidity to the water. That water is present in the atmosphere is here proved by placing a freezing mixture of ice and salt in a beaker of thin glass, the outside of the vessel being clean and dry; in a short time a dew appears on the glass. This increases in quantity and by the intense cold is congealed, so that now we have a thin layer of hoar frost on the glass; and the moisture so deposited and frozen could have been derived from the atmosphere only, in direct contact with the glass. Such is the composition of the atmosphere, in its unvitiated condition—the state in which the Creator designed it to be breathed by His earthly children. Although these atmospheric ingredients are of widely varying specific gravities, there is no separation into layers; on the contrary, the atmospheric gases evince a decided tendency to mingle uniformly; so that air taken from the earth's surface—if there be no near causes of contamination—or from different elevations, over land or above water, the same relative proportions is discovered. Through that strange property of fluids, known as diffusion, both liquids and gases tend to mix; this may be shown by the following simple experiment: You see here two wide mouth glass jars, each capable of holding about a quart; one of them we will fill with dry hydrogen, a gas which is fully 14½ times lighter than air; now let us invert the bottle containing hydrogen over the one containing air, the vessels being placed, as you see, mouth to mouth. It would seem that hydrogen, the lightest and most buoyant substance known to chemistry, would rise to the top and the air, 14½ times heavier than the upper gas, would tend to remain at the bottom. On the contrary, as a light is applied to the mouth of each of the bottles, an explosion results, indicating that in each there was a mixture of hydrogen and air, for neither hydrogen nor air is alone explosive, but when together they form a highly explosive mixture. It is clear then that the very light gas, hydrogen, has risen, and the comparatively heavy substance, air, has risen, to produce a uniform mixture in the two bottles. By similar diffusion, the atmospheric ingredients mingle together to our great advantage.

Air is absolutely indispensable to the respiratory processes of living beings; let us take the human subject as an example. We are conscious of a continuous bellows action of the lungs and certain adjacent organs so long as life lasts; this we call the breathing, and this when analyzed is seen to consist of alternate inhalations and exhalations, with a short interval between during the inhalation a certain quantity of air is drawn into the lungs, and in the succeeding expiration nearly a corresponding quantity (somewhat less) is thrown from the lungs; but a special one and a peculiar one will now be considered, namely, the great difference in composition between the air taken in and that exhaled. In 100 volumes of the pure air of the atmosphere, there are 20.81 volumes of oxygen; this is the excellent motor of the human lungs, with the most inviting manners, Dr. Jekyll and Mr. Hyde in color. This type physiologically of change is exercised by successive tissue between man's food from the mouth entire to the lungs. It is the footing of what pure. As it enters the lungs it is carried by the blood in cells called a hemoglobin; these cells are the hemoglobin cells, and these are substituted with the circulation of oxygen. But the oxygen is not free to trace them. The microscope, however, reveals the fact that the minute branches of tissue tubes terminate in very minute capillaries (meaning hair-like) convey the blood to the surface walls of tissue vessels, and while passing through this, the fine fluid is separated from the air only by the extremely thin walls of the vessels and blood vessels themselves. It has always been a matter that little heed to diffuse if brought together; the tissue is another tenacity, even more exquisite than diffusion, by which fluids are made to pass through separating walls, if these partitions be of all permeable; this is the phenomenon of osmosis, and through it, the gases contained by the blood in its passage through the lungs, pass from the tissue into the vessels channels, to be subsequently expelled from the lungs, while the tissue gaining oxygen diffuses from the vessels cavity into the blood vessels, and so purifies or arrests the blood. If a person's respiration be stopped, as by choking, or by traversing his head in an inert gas or liquid, so oxygen can enter the lungs to aerate the blood, and death relieves the person's pain of suffocation; or as physicians say, of asphyxia, he has to feel been poisoned by the foul products of his own vitiated exertion. Pure air, then, is indispensable to health, in fact it is essential to life.

2. AIR CONTAMINATION is constantly going on, and were it not for a counteracting process of purification, the entire atmosphere would soon become foul. In closed spaces, such as the rooms of dwelling houses, however, there is no chance for purification of the air once vitiated, and the only possible course is to expel the much vitiated air and replace it by pure air from without. Carbon dioxide is abnormal quantity is one of the most constant ingredients of contaminated air, and this is in accordance with what would be very generally supposed from the known facts that carbon dioxide is a constant product of animal and vegetable decay, of animal and human respiration, of ordinary combustion, and of fermentation. Remembering the easy ease with which it dissolves, becoming carbic in the presence of carbon dioxide, we can readily test for this gas. Take a goblet containing some cool lime water; as one blows through this tube into the liquid you see the milkiness becoming apparent. You will remember in a recent lecture on combustion the gaseous products resulting from the burning of a candle were drawn through lime water with a similar result. If the gas issuing from fermenting wort, or from decaying plants be passed into lime water, the presence of the gas will be proved conclusively. The amount of carbon dioxide in air has been regarded as a proper index of purity; though it must not be forgotten that other contaminating substances are formed in many of the processes already referred to. As already seen, the quantity of carbon dioxide ordinarily present in pure air is .04 per cent, or 4 parts in a thousand. Experiment has shown that at what person in a close condition will exhale about 3 cubic feet of this gas per hour. From these facts we may form a good conclusion regarding the rate of contamination from human respiration alone. If a person be shut up in a tight room of 800 cubic feet capacity, he would exhale during an hour 3 cubic feet of carbon dioxide which, added to the amount normally present, would make the quantity 1.5 cubic feet in the 800 cu. ft. of air, or 1.8 cu. ft. per thousand; and this amount—a value far per thousand—is regarded by some authorities as the maximum amount to be tolerated in the air of dwellings. It is plain, then, that in order to keep the contained gases within the prescribed limits during a second hour, the place of the 800 cu. ft. of impure air must be filled by a corresponding of fresh air. Now, 800 cubic feet of air weighs 1.5 pounds, and 1.8 cu. ft. per thousand, is equivalent to a proper requirement in ventilation of a course as to this may seem, there are some cases where supplies will place the amount higher; thus Dr. Billings says an adult needs one cubic foot of pure air per second, or 3600 cu. ft. per hour. These conditions are to adult persons in a condition of fair to moderate activity; children exhale less carbon dioxide given persons in various exercise would exhale more than the average amount.

I take some illustrations that have been cited in this class room. At the late meeting of the Society of Chemical Industry, mentioning 1800 cu. ft. of space, would be contaminated by the exhalations of one person in ten days 12 minutes. A room example of a school capacity, say 20x40x10 feet, and 14 ft. high, containing 10,720 cu. ft. of air, if occupied by 40 children, allowing to each only 200 cu. ft. of air per hour, would be vitiated in less than seven minutes. According to experiments made by Archibald, Oct. 17, 1893, the large Tabernacle building, with its capacity of 1,250,000 cubic feet, would be vitiated in 1,250 minutes, or 20 hours, by 2,000 people, assuming 3 cubic feet per hour, and 1,000 people would vitiate it in 10 hours. Assuming a concentration