quantity of oxygen is absorbed by the skin of the human subject, and a quantity of carbon dioxide, which is relatively larger, is exhaled. Exhalation of carbon dioxide, which is connected with the uses of the skin as a general eliminating organ and is by no means an essential part of the respiratory process, will be more fully considered in connection with the physiology of excretion. Carbon dioxide is given off with the general emanations from the surface, being found, also, in solution in the urine and in most of the secretions. It is well known that death follows the application of an impermeable coating to the entire cutaneous surface; but this is by no means due to a suppression of its respiratory office alone. The skin has other uses, particularly in connection with regulation of the animal temperature, which are much more important.

An estimate of the extent of the cutaneous, as compared with pulmonary respiration, has been made by Scharling, by comparing the relative quantities of carbon dioxide exhaled in the twenty-four hours. According to this observer, the skin performs $\frac{1}{50}$ to $\frac{1}{40}$ of the respiratory office. It is difficult to collect all the carbon dioxide given off by the skin under perfectly normal conditions. In the observations by Aubert, the estimate is very much lower than that given by Scharling.

Asphyxia.

The effects of cutting off the supply of oxygen from the lungs are mainly referable to the circulatory system and have already been considered in treating of the influence of respiration upon the circulation. It will be remembered that in asphyxia the unaërated blood passes with so much difficulty through the systemic capillaries as finally to arrest the action of the heart. It is the experience of experimenters on living animals, that the movements of the heart, once arrested in this way, can not be restored; but that while the slightest regular movements continue, the heart's action will gradually return if air be re-admitted to the lungs.

A remarkable power of resisting asphyxia exists in newborn animals that have never breathed. This was noticed by Haller and others and has been the subject of many experiments. Legallois found that young rabbits would live for fifteen minutes deprived of air by submersion, but that this power of resistance diminished rapidly with age. W. F. Edwards has shown that there exists a great difference in this regard in different species. Dogs and cats, which are born with the eyes shut and in which there is at first a very slight development of animal heat, will show signs of life after submersion for more than half an hour; while Guinea-pigs, which are born with the eyes open, are much more active and produce a greater amount of heat, will not live for more than seven minutes. The explanation of this is that in most warm-blooded animals, during the very first periods of extraüterine life, the demands on the part of the system for oxygen are comparatively slight. At this time, there is very little activity in the general processes of nutrition and in the consumption of oxygen and the exhalation of carbon dioxide. The actual difference between the consumption of oxygen immediately after birth and at the age of a few days is sufficient to explain the remarkable power of resisting asphyxia just after birth.

Breathing in a Confined Space.—An important question connected with the physiology of asphyxia, is the effect on the system, of air vitiated by breathing in a confined space. There are here several points which present themselves for consideration. The effect of respiration on the air is to take away a certain proportion of oxygen and to add certain matters which are regarded as deleterious. The emanation which has been generally regarded as having the most decided influence upon the system is carbon dioxide; but this influence has been much over-estimated. In death from charcoal-fumes, it is generally carbon monoxide which is the poisonous agent. Regnault and Reiset exposed dogs and rabbits for many hours to an atmosphere containing twenty-three parts per hundred of carbon dioxide artificially introduced, and between thirty and forty parts of oxygen, without any ill effects. They took care, however, to keep up a free supply of oxygen.

These experiments are at variance with the result obtained by others, but Regnault and Reiset explained this difference by the supposition that the gases in other observations were probably impure, containing a little chlorine or carbon monoxide. This view is sustained by the experiments of Bernard with carbon monoxide. In animals killed by this gas, the blood, both venous and arterial, is of a bright-red color, which is due to the fixation of the gas by the blood-corpuscles. In this way, the red corpuscles, which act normally as respiratory agents, carrying oxygen to the tissues, are paralyzed, and the animal dies from asphyxia.

In breathing in a confined space, the distress and the fatal results are produced, in all probability, more by animal emanations and a deficiency of oxygen than by the presence of carbon dioxide. When the latter gas is removed as fast as it is produced, the effects of diminution in the proportion of oxygen are soon very marked, and they progressively increase until death occurs. The influence of emanations from the lungs and general surface is undoubtedly very considerable; and this fact, which almost all have experienced more or less, has been fully illustrated in several instances of large numbers of persons confined without proper change of air. Overcrowding is one of the most prolific sources of disease among the poorer classes of society; and there are many forms of disease prevalent in large cities, that are almost unknown in the rural districts and that can be alleviated only by proper sanitary regulations, which, unfortunately, it is often difficult to enforce.

In crowded assemblages, the slight diminution of oxygen, the elevation of temperature, increase in moisture, and particularly the presence of organic emanations, combine to produce unpleasant sensations. The effects of this carried to an extreme degree were exemplified in the confinement of the one hundred and forty-six English prisoners, for eight hours only, in the "Black Hole" of Calcutta, a chamber eighteen feet (5·486 metres) square, with only two small windows, and those obstructed by a veranda. Out of this number, ninety-six died in six hours, and one hundred and twenty-three, at the end

of the eight hours. Many of those who immediately survived died afterward of putrid fever ("Annual Register," 1758). The incident of the "Black Hole of Calcutta" has frequently been repeated on emigrant and slave ships, by confining great numbers in the hold of the vessel, where they were entirely shut out from the fresh air.

The condition of the system has a marked and important influence on the rapidity with which the effects of vitiated atmosphere are manifested. As a rule, the immediate effects of confined air are not developed so soon in weak and debilitated persons as in those who are active and powerful. It has sometimes been observed, in cases where a male and female have attempted suicide together by the fumes of charcoal, that the female has been restored some time after life had become extinct in the male. This is probably owing to the greater demand for oxygen on the part of the male.

When poisoning by confined air is gradual, the system becomes accustomed to the toxic influence, the temperature of the body is lowered, and an animal will live in an atmosphere which will produce instantaneous death in one that is fresh and vigorous. Bernard has made a number of experiments on this point. In one of them, a sparrow was confined under a bell-glass for an hour and a half, at the end of which time another was introduced, the first being still quite vigorous. The second became instantly much distressed and died in five minutes; but ten minutes after, the sparrow which had been confined for more than an hour and a half was released and flew away.

CHAPTER VI.

ALIMENTATION.

General considerations—Hunger—Seat of the sense of hunger—Thirst—Seat of the sense of thirst—Duration of life in inanition—Classification of alimentary substances—Nitrogenized alimentary substances—Non-nitrogenized alimentary substances—Inorganic alimentary substances—Alcohol—Coffee—Tea—Chocolate—Condiments and flavoring articles—Quantity and variety of food necessary to nutrition—Necessity of a varied diet.

In the organism of animals, every part is continually undergoing what may be called physiological wear; the nitrogenized constituents of the body are being constantly transformed into effete matter; and as these constituents never exist without inorganic matters, with which they are closely and inseparably united, it is found that the products of their disassimilation are always discharged from the body in combination with inorganic substances. This process of molecular change is a necessary condition of life. Its activity may be increased or retarded by various means, but it can not be arrested. The excrementitious matters which are thus formed are produced constantly by the tissues and must be continually removed from the organism.

It is evident, from the amount of matter that is daily discharged from the body, that the process of disassimilation must be very active. Its constant operation necessitates a constant appropriation of new matter by the parts, in order that they may maintain their integrity of composition and be always ready to perform their offices in the economy. The blood contains all the materials necessary for the regeneration of the organism. Its inorganic constituents are found generally in the form in which they exist in the substance of the tissues; but the organic constituents of the parts are formed in the substance of the tissues themselves, by a transformation of matters furnished by the blood. The physiological wear of the organism is, therefore, being constantly repaired by the blood; but in order to keep the great nutritive fluid from becoming impoverished, the matters which it is constantly losing must be supplied from some source out of the body, and this necessitates the ingestion of articles which are known as food. Food is taken into the body in obedience to a want on the part of the system, which is expressed by the sensation of hunger, when it relates to solid or semi-solid matters, and of thirst, when it relates to water.

Hunger and Thirst.

The term hunger may be applied to all degrees of that peculiar want felt by the system, which leads to the ingestion of nutritive substances. Its first manifestations are, perhaps, best expressed by the term appetite; a sensation by no means disagreeable, and one which may be excited by the sight, smell, or even the recollection of savory articles, at times when it does not absolutely depend on a want in the system. In the ordinary and moderate development of the appetite, it is impossible to say that the sensation is referable to any distinct part or organ. It is influenced in some degree by habit; in many persons, the feeling being experienced at or near the hours when food is ordinarily taken. If not soon gratified, the appetite is rapidly intensified until it becomes actual hunger. Except when the quantity of food taken is unnecessarily large, the appetite simply disappears on the introduction of food into the stomach and gives place to the sense of satisfaction which accompanies the undisturbed and normal action of the digestive organs; or in those who are in the habit of engaging in absorbing occupations at that time, the only change experienced is the absence of desire for food.

It has been observed that children and old persons do not endure deprivation of food so well as adults. This was noted in the case of the wreck of the frigate Medusa. After the wreck, one hundred and fifty persons, of all ages, were exposed on a raft for thirteen days, with hardly any food. Out of this number only fifteen survived; and the children, the young persons and the aged, were the first to succumb.

Important modifications in the appetite are due to temperature. In cold climates and during the winter season in all climates, the desire for food is notably increased, and the tastes are somewhat modified. Animal food, and particularly fats, are more agreeable at that time, and the quantity of nutriment which is demanded by the system is then considerably increased. In