F. OTHER MEANS OF ABSORPTION

1. Ingestion

Ingestion of toxic materials has been mentioned above as resulting from inhalation. It may also result from many other sources, such as contaminated food, tobacco, or beverages, or from putting fingers or other contaminated objects into the mouth, or from licking the lips. Compared with inhalation, ingestion plays a minor role in the absorption of most toxic materials in industry. However, progressive companies realize that occupational diseases can occur from the careless use of contaminated workrooms as a place in which to eat lunches—all too often without previously washing the hands (cf. also page 130).

2. Absorption through the Skin

Many gaseous and liquid materials are absorbed to a limited extent through the intact skin by way of the air spaces in the hair follicle to the sebaceous glands and the gland cells. Similarly, according to Rothman,[18] any substance may, through the sweat gland ducts, reach the secretory surface of the sweat gland cells after having passed the straight and the convoluted part of the ducts.

Most electrolytes and water do not penetrate the skin in significant amounts. Alkaloids, phenols, oxalic and salicylic acids and esters, lead acetate, and lead oleate are absorbed in appreciable amounts. Salts of lead, tin, copper, arsenic, bismuth, antimony, and mercury are said to penetrate by combining with the fatty acid radical of the sebum. Ammoniated mercury, however, is said not to be absorbed through the skin as such.[18] Nicotine, strychnine, and opium are absorbed readily, but their salts are not. Slight amounts of hydrogen sulfide and rapidly dangerous amounts of hydrogen cyanide may be absorbed from contaminated air. Nitrobenzene, dinitrobenzene, nitrotoluene, dinitrotoluene, (probably) trinitrotoluene, aniline, dimethylaniline, and nitroglycerin are readily absorbed from skin contact with these materials or their solutions. Hodge and Sterner[19] have shown that triorthocresyl phosphate is absorbed through the skin. Alcohols, aldehydes, and acetone are said to be readily absorbed, but from a practical viewpoint there seems to be little significant hazard from this source. Benzene, toluene, xylene, the chlorinated hydrocarbons, and other fat solvents are absorbed to a degree, but the quantities of these materials accumulated in the body in this manner are probably not of a significant order, although tetrachloroethane and other unusually toxic solvents may be exceptions to this statement. Absorption through lesions of the epidermis is much more rapid than through the intact skin.

IV. Standards of Physiological Response

In order to facilitate the comparison of data on the physiological response to

[18] S. Rothman, *J. Lab. Clin. Med.*, **28**, 1305 (1943).
[19] H. C. Hodge and J. H. Sterner, *J. Pharmacol.*, **79**, 225 (1943).

inhalation of atmospheric contaminants, many investigators have tabulated their data in degrees of response such as the following:

Amount producing detectable or other degree of odor.
Amount producing detectable or other degree of irritation.
Maximum amount for repeated daily 8-hour exposures without injury.
Maximum amount for a single 8-hour exposure without serious disturbance.
Maximum amount for a single 1-hour exposure without serious disturbance.
Amount dangerous to life within several (4 to 8) hours.
Amount dangerous to life within ½ to 1 hour.
Amount causing death within a few minutes.

Levels set for industrial practice have been variously labeled as threshold limits, maximum safe concentration, maximum allowable concentration, toxic limit, maximum permissible concentration, and maximum safe practice. What is, of course, the most desired value is the maximum concentration to which an individual may be exposed throughout his or her working day, for an indefinite period of time, without suffering any ill effects. Unfortunately this has been established satisfactorily for extremely few single substances. The human body is fortified with a defense, or detoxication, mechanism able to cope with all toxic materials in amounts below a certain level, called the threshold of intoxication. So long as this threshold of daily intake is not exceeded, there are no harmful effects, but as soon as this level is exceeded, injurious effects result. This level is not a definite and fixed point for any material, and it may vary not only with individuals, but also with bodily conditions of the same individual. There are many degrees or shades of toxicity among the materials encountered in industry, as, for instance, the volatile solvents. All of these are toxic if absorbed into the system in excess, their toxicity being a matter of degree, and none of them meriting the classification nontoxic. How are we to set permissible or safe standards of air contamination for industry?

With very few exceptions all of our so-called "safe" limits are educated guesses. At their best they are estimates rather than actual safe limits. They are limits set after careful consideration of available toxicity data, largely obtained from exposure of animals, which further research or experience may or may not substantiate. Why, then, pretend that we know the maximum safe limit unless, as in the case for carbon monoxide and other asphyxiants, lead, mercury, and possibly a few other materials, we have the data to establish the point? Even with the asphyxiants we perhaps are not positive of the effects of prolonged inhalation of concentrations too low to cause unconsciousness, and regarding the safe limit for lead, some evidence points to a need for specifying the physical state and chemical combination of the lead. It seems logical that we should, as a guide to the uninitiated, and a check upon the alarmist, and possibly the unscrupulous, without undue delay, set suggested maximum concentrations for materials as soon as, if not before, they attain industrial importance. We should call them hygienic standards, recommended good practice, tentative threshold limits, or suggested maximum concen-