Creolin is an alkaline emulsion of the cresols and other products contained in crude carbolic acid with soap, and is as powerfully disinfectant as pure carbolic acid; it is used in five-per-cent. emulsions.

Lysol is similar to creolin and has about the same germicidal value.

Tricresol is a refined mixture of the three cresols (meta-, para-, and orthocresol); it is soluble in water to the extent of 2.5 per cent., and is about three times as strong as carbolic acid.

The *aniline dyes*, many of them, possess marked germicidal properties. Methyl violet and malachite green destroy the typhoid bacillus in bouillon cultures in 1 to 200 solution in two hours, and the pyogenic cocci in less time. Even in 1 to 100,000 solution they are said to inhibit bacterial growth.

The *essential oils* are also strongly disinfectant. Oil of cinnamon, cloves, thyme, sandalwood, etc., destroy most bacteria in from one to twelve hours. Thymol and eucalyptol have about one-fourth the strength of carbolic acid. Oil of peppermint in 1 to 100 solution inhibits bacterial growth. Oil of turpentine in 1 to 200 solution does the same. Camphor has very little antiseptic action. (See also article on *Disinfectants.*)

III. *Gaseous Disinfectants.—Formaldehyde* is a gaseous compound of strongly disinfectant properties and possessed of an extremely irritating odor. At a temperature of 68° F. the gas is polymerized, that is to say, a second body is formed composed of a union of two molecules of CH_2O. This is known as "paraformaldehyde," and is a white soapy substance, soluble in boiling water and alcohol; it exists in the solution of commerce ordinarily called "formalin," which is a clear watery liquid containing from 33 to 40 per cent. of the gas and 10 to 20 per cent. of methyl alcohol, its chief impurity. When this is concentrated, about 40 per cent. paraformaldehyde results. Dried over sulphuric acid a third body—"trioxymethylene"—is produced, consisting of three molecules of CH_2O, and is a white substance almost insoluble in water or alcohol, and giving off a strong odor of formaldehyde. The solid polymers of formaldehyde when heated are again reduced to the gaseous condition; ignited they finally take fire and burn with a blue flame, leaving but little ash.

Formaldehyde has an active affinity for many organic substances and forms with some of them definite chemical combinations. It combines readily with ammonia to produce a compound called ammoniacal aldehyde which possesses neither odor nor the antiseptic properties of formaldehyde. This action has been made use of in neutralizing the odor of formaldehyde when it is desired to dispel it rapidly after disinfection of habitations. Formaldehyde also forms combinations with certain aniline colors, viz., fuchsin and safronin, modifying their shades. The most delicate fabrics of silk, wool, cotton, fur, leather, etc., however, are unaffected in texture or color by formaldehyde. Iron and steel are attacked after long exposure to the gas or its solution; but copper, brass, nickel, zinc, silver, and gold work are not at all acted upon. Formaldehyde unites with nitrogenous products of decay, fermentation, and putrefaction, forming true chemical compounds, which are odorless and sterile. It is thus a complete deodorizer. Formaldehyde has a peculiar action upon albumin, which it transforms into an insoluble and indecomposable substance. It is to this property of combining chemically with albuminous substances forming the protoplasm of bacteria that formaldehyde owes its germicidal powers. It is also an excellent preservative of organic products for the same reason; and use has been made of it to preserve meat, milk, and other food products. But according to Trillat and others it renders these substances indigestible and unfit for food. It has been successfully employed, however, as a preservative of botanical, pathological, and histological specimens.

The vapors of formaldehyde are extremely irritating to the mucous membrane of the eyes, nose, and mouth, causing profuse lachrymation, coryza, and secretion of saliva. Aronson has stated that rabbits and guinea-pigs, allowed to remain for twelve to twenty-four hours in rooms which were being disinfected with formaldehyde gas, were unaffected by the fumes. But other experimenters have found that animals, such as dogs, cats, etc., accidentally exposed for some time to the action of the gas, suffered severely, and some have died from its effects. It would seem, therefore, that although formaldehyde is comparatively non-toxic to the higher forms of animal life, nevertheless a certain degree of caution should be observed in its use. Roaches, flies, bedbugs, and other insects are, as a rule, not killed by formaldehyde gas in the process of disinfecting a room.

The results of numerous experiments in practical disinfection with this agent have shown that two and one-half per cent. by volume of the aqueous solution of formaldehyde, or one per cent. by volume of the gas, are sufficient to destroy the vegetative forms of pathogenic bacteria in a few minutes, when freely exposed to its influence and in a moist condition. The germicidal power of the gas depends not only upon its concentration, but also upon the temperature and the condition of the object to be sterilized. As with other gases, it has been found that the action is much more rapid and complete at higher temperatures (35° to 45° C.), and when the test objects are moist and freely exposed, than at lower temperatures and when the objects are dry and in mass; the gas possesses when dry little or no penetrative power. Still it has been repeatedly demonstrated that it is possible to disinfect the surface of rooms, and articles contained in them, under the conditions of temperature and moisture ordinarily found, by an exposure of a few hours to a saturated atmosphere of the gas.

Sulphur dioxide gas has been extensively used for the disinfection of hospitals, ships, apartments, etc. Its action depends upon the formation of sulphurous acid in the presence of moisture. In its pure state SO_2 does not destroy spores, and even on vegetative forms its germicidal effect is uncertain. An exposure, however, for eight hours to an atmosphere containing at least four volumes per cent. of this gas in the presence of moisture will destroy most, if not all, the common non-spore-bearing pathogenic bacteria. It is not so prompt or powerful in its action as formaldehyde gas, which in many respects is a preferable disinfectant, especially in cases where the sulphurous acid formed from the sulphur dioxide may have an injurious effect upon the articles to be disinfected.

Peroxide of hydrogen is an energetic disinfectant, and in two-per-cent. solution (about forty per cent. of the ordinary commercial article) will kill the spores of anthrax in from two to three hours. A twenty-per-cent. solution of good commercial peroxide of hydrogen will quickly destroy the pyogenic cocci and other non-spore-bearing bacteria. On account of its rapidity of action and non-poisonous character it is a useful and safe disinfectant, but it combines with organic matter and becomes inert, being apt to deteriorate if not properly kept.

Chlorine is a powerful gaseous germicide, owing its activity to its affinity for hydrogen and consequent release of nascent oxygen, when it comes in contact with micro-organisms in a moist condition. Like formaldehyde gas and sulphur dioxide it is much more active in presence of moisture than in a dry condition. Dried anthrax spores exposed for an hour in an atmosphere containing 44.7 per cent. of dry chlorine were not destroyed; whereas when the spores were previously moistened and exposed in a moist atmosphere for the same time, four per cent. was effective, and when the time was extended to three hours, one per cent. destroyed their vitality. The anthrax bacillus, in the absence of spores, was killed by an exposure in a moist atmosphere containing 1 part to 2,500 for twenty-four hours. In watery solution 0.2 per cent. kills spores within five minutes. and the vegetative forms almost immediately.

Chloride of lime owes its efficacy to the chlorine it contains in the form of hypochlorites. A solution of one-half to one per cent. of fresh chloride of lime in water will

kill most bacteria in from one to five minutes; a five-per-cent. solution usually destroys spores in an hour.

Bromine and *iodine* are of about the same germicidal value as chlorine, in the moist condition; but, like chlorine, they are not applicable for general use in house disinfection on account of their poisonous and destructive properties. They are useful for the disinfection of sewers, and other similar places. Trichloride of iodine in 0.5-per-cent. solution destroys the vegetative forms of bacteria in about five minutes.

(*The relation of bacteria to disease*—infection, susceptibility, resistance, immunity, recovery, etc.—will be considered elsewhere; as will also the subject of *bacteriological technique.*)

SPECIAL BACTERIA.

Under this heading will be described the chief characteristics of the more important bacterial species pathogenic for man and other animals. There are many bacteria which have been found in certain diseases, but their causal relation to the disease has not yet been proven, and they have also been found in other affections. These we cannot treat of here. Nor will space allow us to consider the non-pathogenic species, or those which do not affect man, but are pathogenic for the lower animals only.

THE TUBERCLE BACILLUS (*Koch's Bacillus Tuberculosis*).—The infectious nature of tuberculosis was first demonstrated by Villemin in 1865, when by inoculation with tuberculous material he communicated the disease to healthy susceptible animals. In 1882 Koch discovered the bacillus tuberculosis, which is now known to be the specific cause of the disease.

Microscopical Appearances.—The tubercle bacillus occurs in sputum and in cultures as slender rods from 1.5 to 4 μ long and about 0.4 μ broad, often slightly curved. The bacilli usually occur singly, but in cultures sometimes form chains of four to six elements; occasionally peculiar, club-like forms and branches have been met with, from which they have been supposed to be allied to the actinomyces group of fungi or streptothrices (see Plate X., Fig. 1).

Motility.—Non-motile.

Spore Formation.—The clear spaces or vacuoles which are present in stained preparations, and which have been described by some authorities as spores, are probably due to degenerative processes, as they do not show the form of spores nor is anything known as to their power of resistance or germination.

Staining Reaction.—The tubercle bacilli stain with difficulty, but once stained they retain the dye with great tenacity. At present the methods most commonly employed for staining tubercle bacilli, though there are many modifications of these, are the Ziehl-Neelsen with carbol fuchsin, and the Koch-Ehrlich with aniline water and gentian violet. For special methods of preparing and staining cover-glass specimens and sections, see *Micro-Organisms: Technology.*

The peculiar staining reaction found in the case of the bacillus tuberculosis is not confined to that organism alone, as other similar organisms, when treated in like manner, react in the same way. Thus it has to be differentiated from the *smegma bacillus*, located in the smegma, often seen beneath the prepuce and upon the vulva, both normally and in disease; *Lustgarten's bacillus of syphilis*, found principally in the primary lesions associated with that disease; the *bacillus of leprosy;* and *acid-resisting* or *grass bacteria* found in butter. Hueppe differentiates the first three organisms and the tubercle bacillus as follows:

1. Treat the preparation, stained with carbol fuchsin, with sulphuric acid, and the syphilis bacillus, if present, is at once decolorized.

2. If not immediately decolorized, treat with alcohol, and if it is the smegma bacillus it will lose color.

3. If it is still not decolorized, it is either the leprosy or the tubercle bacillus. According to Baumgarten, the leprosy bacillus is stained by an exposure of six or seven minutes to a cold saturated, watery solution of fuchsin, and retains the stain when subsequently treated with acid alcohol (nitric acid 1 part to alcohol 10 parts). When treated for the same length of time, the bacillus tuberculosis does not ordinarily become stained.

Biological Characters.—Aërobic; does not grow in the absence of oxygen. Growth takes place between 29° and 42° C.; optimum temperature at 37° C. Under all circumstances the growth is slow. On the ordinary agar and gelatin culture media development is very scanty; for the cultivation of tubercle bacilli practically the only media employed are coagulated blood serum and four to six per cent. glycerin agar and glycerin bouillon.

It is very difficult to obtain a *pure culture* of tubercle bacilli, because they grow so slowly and require for their development an incubator temperature, and because owing to the slow growth, the other bacteria present in tuberculous material, as sputum, grow more rapidly and take possession of the culture medium before the tubercle bacillus has had time to form colonies. It is therefore best, unless human tissues can be obtained free from other infection, first to inoculate some guinea-pigs (which are very susceptible) both subcutaneously and intraperitoneally, with the sputum, and then to obtain cultures from the animal as soon as the tuberculous infection has fully developed. The animals thus inoculated usually die at the end of three to four weeks or more. It is better, however, to kill a guinea-pig which by its enlarged glands shows evidence of tuberculosis, and to remove, with the greatest antiseptic precautions, one or more nodules from the lungs, spleen, or lymphatic glands, and inoculate with this the solid culture medium (blood serum) by rubbing it directly over the surface; or a part of it may first be crushed between two sterilized glass slides and then transferred to the serum and gently rubbed over its surface.

Growth on Coagulated Blood Serum.—On this medium, which is generally employed to obtain the first culture, the growth becomes visible after ten to fourteen days at 37° C., and at the end of three to four weeks a distinct, characteristic development has occurred. Small, grayish-white, dry, crumbly scales first appear on the surface; then as development progresses there is formed an irregular, membranous-looking layer. On removing a small portion of this and placing it on a cover glass without rubbing, staining, and examining under the microscope, the bacilli will be seen to present a characteristic appearance and to be arranged in parallel rows of variously curved figures.

Growth on Glycerin Agar.—Owing to the greater facility of preparing and sterilizing glycerin agar, and the more rapid and abundant development of the bacilli, which have become accustomed to growth outside the body, this medium is now usually employed in preference to blood serum for preserving cultures. At the end of fourteen to twenty-one days the development is more luxuriant than upon blood serum after several weeks. When numerous bacilli have been distributed over the surface of the medium, a rather uniform, thick, white layer, which later becomes yellowish in color, is developed; when the bacilli are few in number, separate colonies are developed with more or less irregular outlines.

Growth on Glycerin Bouillon.—On bouillon containing about five per cent. of glycerin the tubercle bacillus also grows readily if a fresh thin film of growth from the glycerin agar is floated on the surface. This medium is used for the production of "tuberculin." The small piece of pellicle removed from the previous culture continues to enlarge while it floats on the surface of the liquid, and in the course of from three to six weeks covers it completely as a single film, which on agitation breaks up and settles to the bottom of the flask, where it ceases to develop further. The liquid remains clear, containing in solution the products formed by the growth of the bacillus.

Vitality.—Tubercle bacilli in pure cultures are very susceptible to the action of direct sunlight, being destroyed in from a few minutes to some hours, according to the thickness of the growth. Exposed to diffuse daylight they are killed in a week. Though they do not form spores, as far as known, the bacilli have a somewhat greater resisting power to heat and desiccation than many other pathogenic bacteria, frequently retaining their virulence in a dried condition at the ordinary temperatures for months. Portions of the lung from a tuberculous cow, dried and pulverized, produced tuberculosis in guinea-pigs at the end of one hundred and two days. Dried tuberculous sputum may retain its virulence for two or three months or more. An instance is reported by Ducor of a healthy family having become infected with tuberculosis from living in a room which had been occupied by a consumptive patient two years before, and on examining the sputum-stained wallpaper not only were tubercle bacilli found in it, but when inoculated into guinea-pigs they died of the disease. Exposure to 100° C. dry heat does not kill the bacilli in twelve hours; but moist heat at 60° C. destroys them in fifteen minutes. Cold has little or no effect upon them. The resisting power of this bacillus against chemical disinfectants is considerable, especially in sputum, where the organisms are protected by mucus from penetration by the germicidal agent. They are not always destroyed by the gastric juice in the stomach, as has been shown by successful experiments in feeding to susceptible animals. They are killed in sputum in about six hours by an equal amount of a three-per-cent. solution of carbolic acid, and in about one hour by a five-per-cent. solution. Bichloride of mercury is unsuitable for the disinfection of sputum unless used in very strong solution (1 to 500). Pickling and smoking are said not to destroy the virulence of tuberculous meat.

Occurrence.—The tubercle bacillus is a strict parasite,—that is to say, it does not grow under natural conditions outside of the bodies of man and animals. It has frequently been found, however, in the dust of hospitals, dwellings, railways, street cars, etc., in places where consumptives have expectorated. Very rarely has it been found in the air. The milk of tuberculous cows, even when the udder is not affected, very often contains tubercle bacilli; they are also found in butter.

Post-mortem examinations of many individuals who have died from some other cause than tuberculosis have revealed the presence of healed tuberculous foci. It has been estimated that sixty-six per cent. of all mankind have some evidence of tuberculosis, old tuberculous lesions, of primary or secondary origin. Tubercle bacilli are said to have been found also in the secretions of the nose and throat of healthy persons, nurses and doctors, who have been in constant association with tuberculous patients.

The tubercle bacillus is the essential cause of all forms of tuberculosis: the various affections of the lungs and other organs, lupus, scrofula, and inflammation of the bones and joints. The following diseases have also been traced to tuberculous infection: so-called "inoculation lupus," tuberculosis verrucosa cutis, and scrofuloderma; choroidal tuberculosis, idiopathic pleurisy, etc. Indeed, all organs and portions of the body may become affected with this disease.

Many cases of tuberculosis are produced by the tubercle bacillus alone, but very frequently streptococci and other pyogenic cocci play an important part in the production of fever and the destruction of tissue, as in phthisis, by suppurative processes.

Tuberculosis is very common among cattle, chiefly in cows and rarely in calves. According to Klepp, from abattoir inspections in Germany, up to thirty-five per cent. of cattle, eighty per cent. of cows, and three per cent. of calves, are commonly found tuberculous. The disease is also quite frequent in young pigs; less so in sheep, goats, horses, dogs, and cats. Rabbits and guinea-pigs are also not uncommonly spontaneously affected with tuberculosis, when kept in cages together with infected animals. Monkeys in confinement almost invariably die from tuberculosis. Wild animals are comparatively free from the disease; and so are birds, except canaries and parrots.

Pathogenesis.—As seen from the above many animals besides man are naturally susceptible to tuberculosis. Among test animals guinea-pigs are the most susceptible, and on this account they are commonly used for the detection of tubercle bacilli in suspected material by inoculation. When inoculated with the minutest quantity of living tubercle bacilli they usually succumb to the disease. Infection is most rapidly produced by intraperi toneal injection, death following a large dose in from ten to twenty days. On autopsy the omentum is found to be constricted in sausage-like masses and converted into hard knots containing many bacilli. There is often no fluid in the peritoneal cavity, but generally in both pleural sacs. The spleen is enlarged, and the various organs contain tubercle bacilli. After smaller doses death may be prolonged from four to eight weeks, when the peritoneum and interior organs are found to be filled with tubercles. On subcutaneous injection into the abdominal wall there is thickening of the tissues about the point of inoculation, which breaking down in a week leave a sluggish ulcer covered with cheesy matter. The neighboring lymph glands are swollen, and after two or three weeks they may attain the size of hazelnuts. Soon an irregular fever is set up, and the animal becomes emaciated, usually dying within four to eight weeks. If the injected material contain only a few bacilli, the wound at the point of inoculation may heal and death be postponed for a long time. The lymphatics undergo cheesy degeneration, the spleen is much enlarged, and throughout its substance, which is dark red in color, are masses of nodules. The liver is also enormously swollen, streaked brown and yellow, and the lungs are filled with grayish tubercles; but the kidneys, as a rule, contain no tubercles. Tubercle bacilli are always found in the diseased tissues, but the more chronic the process the fewer are the bacilli present.

Rabbits are also quite susceptible to tuberculosis by inoculation, but much less so than guinea-pigs. In these animals death almost always follows injection of tuberculous material into the anterior chamber of the eye; producing local lesions, softening of the neighboring lymph glands, lesions of the lungs, general miliary tuberculosis, and death in several weeks or months. Subcutaneous inoculations are very much less effective; but intravenous and intraperitoneal inoculations usually cause general tuberculosis and death in a few weeks. Field-mice and cats are also readily infected by artificial inoculation; rats, white mice, and dogs only when very large doses are given. Canaries and parrots are susceptible; fowls and pigeons only slightly so; and other birds and cold-blooded animals are apparently immune.

Besides the artificial modes of infection already alluded to, tuberculosis may be produced in animals susceptible to the disease by *feeding* them with tuberculous material. This has been repeatedly done with milk, sputum, etc., containing tubercle bacilli. Here evidence of infection is usually shown in the mesenteric glands before the intestinal walls are affected; indeed, there may be no local lesions in the intestines at all. Under such conditions, infection is probably caused by absorption of the poisons through serous or mucous membranes.

The experimental production of tuberculosis by *inhalation* of bacilli has been demonstrated by Koch in guinea-pigs, rabbits, mice, etc. In these cases the bacilli were usually administered in the form of fine spray; the inhalation of dry tuberculous dust has seldom proved experimentally successful.

The tubercle bacillus acts upon the tissues by means of the poisons which it produces as the result of its growth. Soon after entrance into the tissues of either living or dead bacilli, the cells surrounding them begin to show signs of irritation. The connective-tissue cells become swollen and undergo mitotic division, the resultant cells being distinguished by their large size and pale nuclei. A small focus of proliferated epithelioid cells is thus formed about the bacilli, and according to the intensity of the inflammation these cells are surrounded by a larger or smaller number of the lymphoid cells. When living bacilli are present and multiply, the lesions

progress, the central cells degenerate and die, and a cheesy mass results, which later may lead to the formation of cavities. Dead bacilli, on the other hand, give off sufficient poison to cause less marked changes only, and never produce cavities. Of the gross pathological lesions produced in man by the tubercle bacilli the most characteristic are small nodules, the so-called miliary tubercles. These when young, and before they have undergone degeneration, are gray and translucent in color, somewhat smaller than a millet seed in size, and hard in consistence. But miliary tubercles are not the sole tuberculous products. The tubercle bacilli may cause the diffuse growth of tissue identical in structure with that of miliary tubercles—that is, composed of a basement substance containing epithelioid, giant, and lymphoid cells. This diffuse tubercle tissue also undergoes cheesy degeneration.

When caseation is rapidly spreading, as in acute tuberculosis, the bacilli are usually abundant, being scattered in irregular groups through the tissues. Occasionally they are found in the leucocytes, and in the giant and epithelioid cells. The more chronic the lesions the fewer they are in number.

Modes of Infection.—The chief modes of infection by the tubercle bacillus are through the respiratory tract or the intestines, more rarely through wounds of the skin, and still more rarely through the sexual organs. Pulmonary tuberculosis, as a primary infection, and not occurring in young children, may be considered to be caused chiefly by the direct transmission of tubercle bacilli through kissing, soiled hands, handkerchiefs, etc., or by the inhalation of tuberculous dust. Intestinal and mesenteric tuberculosis, which is rare among adults and common with children, is probably due not only to swallowing the bacilli received in the above-mentioned ways, but also to the ingestion of tuberculous milk. Lupus is probably always produced by the inoculation of tubercle bacilli on the skin or mucous membranes, the original seat of the disease being often on a wounded surface. Localized skin tuberculosis is sometimes produced by accidental inoculation at autopsies. The transmission of infection through the sexual organs of the male or female, though possible, is extremely rare. There seems to be some evidence of the communication of tuberculous infection from the mother to the fœtus in animals; and two cases are recorded of probable placental tuberculosis in the human fœtus. But we have no reason to suppose that infection of the ovum of healthy mothers from the paternal side ever does occur, even when the father has tuberculosis of the scrotum or seminal vesicles. The mere fact that statistics show a greater frequency of tuberculous diseases in children during the first than in the following years of life does not strengthen the hypothesis of infection *in utero*; for nursing babies would naturally be more exposed to infection through the mother's milk and through personal contact than others; and, besides, the more tender the life of the infant the more susceptible it would be ordinarily to indirect infection from a tuberculous mother.

By far the commonest mode of infection, therefore, is undoubtedly by means of tuberculous sputum, which, being coughed up by consumptives and carelessly expectorated, dries and distributes numerous virulent bacilli in the dust. As long as the sputum remains moist there is no danger of dust infection, but only of direct contact. A great number of the expectorated and dried bacilli very probably die, especially when exposed to the action of direct sunlight; but when we consider the enormous masses which are expectorated,* it is evident that a sufficient quantity remains alive to produce infection in the immediate vicinity of consumptives unless precautions are taken to prevent it. There is comparatively little danger of infection in the streets or at a distance from consumptive patients, because even if present in the dust, the tubercle bacilli have become so diluted that they are not much to be feared. It may, therefore, be said that the probability of infection from tuberculosis in general is not so great after all, but at the same time it is all the more to be dreaded and guarded against in the immediate neighborhood of consumptives. Those who are most liable to infection from this source are the families, nurses, fellow-workmen, fellow-prisoners, etc., of persons suffering from the disease. In this connection, also, attention may be drawn to the fact that rooms which have been recently occupied by consumptives are not infrequently the means of producing infection (as has been clinically and experimentally proved) from the deposition of tuberculous dust on furniture, walls, floors, etc. Flügge has lately pointed out that in coughing, sneezing, and even in speaking, very fine particles of secretion, containing tubercle bacilli, may be thrown out and carried by air currents many feet from the patient and remain suspended in the air for a considerable time. For this reason consumptives should be careful to hold their hands or a handkerchief before their mouths, or at least avoid as much as possible contaminating other persons with whom they come in contact.

Phthisical sputum, however, cannot be held responsible for the occurrence of all human tuberculosis. Milk also serves as a frequent conveyer of infection, whether it be the milk of nursing mothers suffering from consumption or the milk of tuberculous cows. The transmission of tubercle bacilli in the milk of tuberculous cows has been abundantly proved by feeding and inoculation experiments on animals. Formerly it was thought that in order to produce infection by milk there must be local tuberculous infection of the udder; but it is now known that tubercle bacilli may be found in milk when an internal organ is infected, and when no disease of the udder, so far as careful inspection goes, seems to exist. The milk of all cows, therefore, which have any tuberculous infection whatever, must be considered as possibly containing tubercle bacilli. With regard to the flesh of tuberculous cattle, the same conditions hold good as in the infection by milk, only the danger is considerably less from the fact that meat is usually cooked, and also because the muscular tissues are seldom attacked. In view of the great mortality from tuberculous diseases among mankind, the legislative control and inspection of cattle and milk would seem to be an absolute necessity. As a practical and simple method of preventing infection, especially among children, the sterilization (by heat) of the milk used as food must commend itself to all. At the same time, it should be stated, however, that there is very little actual proof that human tuberculosis has come from milk or food infected with bovine tuberculosis, nor do we know positively whether the bacilli of bovine tuberculosis are equally as virulent for man as for animals. But from the fact that human tuberculosis produces bovine tuberculosis, there is strong presumptive evidence of the reverse also being true.

Individual Susceptibility.—Another most important factor in the production of tuberculosis, as of all infectious diseases, is individual susceptibility. That this susceptibility or "predisposition," improperly so called, may be either inherited or acquired is now an accepted fact in medicine. There is no doubt that great differences exist in different persons in their susceptibility to tuberculosis, as there are also differences in the intensity of the tuberculous process in the lung. The fact that individuals contracting tuberculosis from the same source are attacked with different severity, and that there is, as a rule, no great variation in degrees of virulence in the tubercle bacilli of different origin, shows that this depends upon something else than a variation in virulence of the infection. The results of post-mortem examinations also demonstrate that many cases of pulmonary tuberculosis evidently occur without showing any visible signs of disease, and heal spontaneously. The possibility of favorably influencing, in an existing tuberculosis, the course of the disease by treatment proves, too, that under natural conditions there is a varying susceptibility. Clinical experience teaches likewise, that the children

* Nutall has estimated that from one and one-half to three billion virulent tubercle bacilli may be expectorated by a single tuberculous individual in twenty-four hours.