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F. W. Brewer

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THE AGRICULTURAL COLLEGE
OF UTAH.

Experiment Station.

BULLETIN NO. 41.

TUBERCULOSIS.

By F. W. BREWER, M. D., Biologist.

December 31, 1895.
STATION STAFF.

J. H. Paul, .................. Director
E. S. Richman, .......... Horticulturist and Entomologist
A. A. Mills, .................. Agriculturalist
J. A. Widtsoe, .................. Chemist
F. W. Brewer, .................. Biologist
S. Fortier, .................. Hydraulic Engineer
F. B. Linfield, ........ Dairyman
Paul Fischer, .................. Veterinarian
James Dryden, ........ Clerk and Stenographer
H. E. Hatch, .................. Treasurer

The Bulletins will be sent free to any address in the United States on written application to the Experiment Station, Logan, Utah.
One of the most dreaded diseases which afflict the human race is "Tuberculosis." It is also the most fatal, as estimates based on reliable statistics show that at least one out of every eight of mankind die from the disease. It has been a scourge throughout historical time and has been known under the various names of Phthisis, Consumption, Wasting Disease, Tuberculosis, etc. The researches of Professor Koch of Germany in 1881 and since that date have proved that not only Tuberculosis has been produced by the germs of which he was the discoverer, but that Scrofula, Tabes, Hydrocephalus, etc., are all the production of the same germ.

Consumption has been the disease that has caused the death of nearly all wild animals that have been captured and confined in Zoological gardens and Menageries. It has also been, and is, the disease most productive of sickness and death amongst domestic animals, especially amongst those that are kept in an unsanitary condition or with unsanitary surroundings.

Consumption is more or less present in all climates and at all altitudes, although doubtless there are some situations and some climatic conditions at and under which the disease flourishes much more than in other climates. The
dry atmosphere of some of the Southern States, of New Mexico and of Arizona, have been supposed to be inimical to consumption. The Tennessee mountains and the slopes of the Rockies have also been looked upon as sanitaria for consumptive sufferers. Yet, in those localities when once it has been introduced, it has spread; and even on the mesas of Mexico—6,000 or 7,000 feet above the sea level it is somewhat prevalent.

The sheltered mountain valleys of Utah are comparatively free from this fell disease, but we have proof that even here, when once it has gained a footing, it can grow and spread, becoming an important factor in the shortening of the lives of both men and animals, thus producing great financial loss to the community. It should be, therefore, incumbent on every inhabitant of Utah to aid in suppressing in its beginning a disease, which, if neglected, may cause us at some future time to lament our supineness.

Tuberculosis is an infectious disease produced by a parasitic germ called a bacillus, which causes the formation in the lungs, liver, and other organs of the body, of cheesy nodes or masses called tubercles.

Probably to some of the readers of this bulletin, the foregoing statement may not be very plain. I will, therefore, endeavor to explain what is meant thereby.

Germs or bacteria are small plants visible only under the higher powers of the microscope; so small that a million of them can be contained in a drop of fluid. These reproduce so quickly and incessantly that, if there were no counteracting agency destroying them, the progeny of a single germ would in fifteen days fill oceans. They are not the producers of disease alone, though some varieties produce very virulent and quickly fatal diseases; but other varieties are assistants to human life, by acting as scavengers in the destruction of injurious organic matter; while still others are of great service in dairy operations.

They are either of a rod shape, called bacilli; spherical called micrococci; or corkscrew shape, called spirilla. When they are alive in fluids and are examined under the micro-
scope, they may be seen moving about in all directions, some slowly, others quickly, some rolling, others wriggling, but all in incessant motion. This motion is caused and directed by small whip-like projections from one or both ends of the organism, which are very difficult to distinguish even under the very highest powers of the microscope. These projections are known by the name of cilia.

The conditions which the bacteria require to flourish luxuriantly are the presence of warmth, moisture, oxygen (with some exceptions) and some organic matter.

When the germ dies, spores or seeds are frequently set free, and though a germ may in some cases be easily killed, the spore is very tenacious of life, and may be revived under favorable conditions long after the death of the germs.

The germ that produces tuberculosis is very small, being only about 1-2500 of an inch in length; it occurs singly, in pairs, or in chains of three or four connected end to end. It lives chiefly as a parasite in the animal body. It can be cultivated in artificial media, with the addition of 5 per cent. of glycerine, and the best temperature for growth is 100 to 102 Fahrenheit.

In 1882 Dr. Robert Koch of Berlin, whose reputation since has become world wide, was able to prove the existence of the bacillus tuberculosis by showing it in the sputum or in the tubercles, of more than 100 cases of consumption, and he also proved that the disease could be produced in healthy animals, by inoculating them with a portion of diseased lung, or with a pure culture of the germ, grown in the laboratory in a glass tube, or in the ordinary medium of beef broth and gelatine. The number of animals submitted to inoculation by Dr. Koch before he made known his discovery was nearly five hundred and amongst the number were guinea pigs, rabbits, rats, mice, cats, dogs, pigeons and fowls.

The bacillus tuberculosis, in common with other germs, is stained by some of the aniline dyes. It however absorbs the dye very slowly, but when absorbed retains it very tenaciously, and by this means it is easily recognizable un-
der the microscope. Sputum that is suspected of containing the tuberculosis germ is spread in a light film over the surface of a cover glass (used in microscopy) and after drying, is immersed in a warm specially prepared solution of fuchsine (an aniline dye) until it is deeply stained; it is then decolorized by an acid solution, which will remove the dye from the mucus of the sputum but not from the germ; the cover glass is then immersed in a dye solution of a contrasting color, when the sputum will be stained by it, but the germ will not be stained. If fuchsine and methylene blue have been the dyes used, the germs, under the microscope, will appear red rods, contrasting strongly with a blue ground color. If any other bacteria should be present they will also be stained blue.

The bacillus tuberculosis may be easily destroyed by ordinary disinfective solutions, such as bichloride of mercury, carbolic acid, etc., etc. It can also be killed by several hours direct exposure to strong sunlight, but, unfortunately, in the nature of its life history, it is very rarely exposed to direct sunlight. It is more often exposed to the heated, sheltered and shaded atmosphere of stores, living-rooms and barns. In those places the germs are generally subjected to a natural drying process, which renders them still more dangerous. The sputum from a human being expectorated upon the floor, or received into a handkerchief, becomes dry and reduced to a powder, which is carried in the air, and by the act of breathing (inspiration) passes into the lungs of some other being; there the germs establish themselves, increase in number and produce injurious effects in the substance of the lungs.

A similar discharge from cattle adhering to the manger may be licked up by other cattle and the disease may thus be spread.

Drinking troughs used indiscriminately by a large number of cattle may also be the means of infection, as the germs can be carried as well through the medium of water as through the medium of air.
Freezing retards the growth of the germ, but does not kill it.

The bacillus tuberculosis is considered by all the best authorities to be the real and active cause of tuberculosis, but, without doubt, the surroundings of cattle as well as the surroundings of human beings, are strong contributaries to the spread, or to the retardation, of the disease. Close, ill-ventilated rooms for mankind; crowded halls filled with the impure air of hundreds or thousands of people; the reluctance of many families to admit the pure air of heaven, or the bright sunlight into their dwellings, are all important factors towards the predisposition of the human body to become infected with any infectious disease; and the disease once having taken root, requires no more favorable conditions under which to develop and spread. Dark, dirty, badly ventilated stables or barns are as injurious to cattle and horses, as dark, ill-ventilated rooms are to human beings, and are equally efficacious in aiding to produce disease.

Underfed animals are also very liable to be attacked by tuberculosis and, in fact, any circumstances that tend to operate against a high standard of health, and that serve to derange the digestive apparatus, or that decrease the natural resistive power of the animal organism, are all conducive to the development and extension of all infective diseases. If the digestive juices of the stomach be deficient in their natural properties, germs, that would otherwise be destroyed in the process of digestion, may pass on into the intestines and there find a suitable position and fluids well adapted to their growth and increase.

It has been proved by the experience of some of the New York hospitals, that, of a number of individuals dying of other diseases a considerable percentage of them have revealed, when subjected to post mortem examination, that at some period of their lives their lungs have been invaded by the tuberculosis germs, and that the slight lesions occasioned thereby have been healed over by the protective power of the natural forces of the body. This fact, how-
ever, while buoying us up with the hope that those of our families, who may be, or may become infected with tuberculosis, have still, if their strength have not waned, and the rest of their condition is healthy, a chance of naturally overcoming the disease, will also thoroughly demonstrate to us that tuberculosis is even more widely and generally spread, than is currently understood; it is therefore more urgently necessary to limit the ravages of the disease, as promptly and extensively as may be in our power. The people who were infected with tuberculosis and recovered therefrom, were, during the existence of the disease, capable of spreading infection in their environments.

So cattle that are diseased with tuberculosis, but that may not succumb to it for several years, may during the whole of that time, be the means of spreading the disease to other cattle and directly or indirectly to human beings.

According to the vital statistics of the United States Census of 1880, (those of the United States Census of 1890 are not yet published) the total number of deaths in the United States, during the census year ending May 31, 1880, from consumption, were 91,270,* while the total number of deaths from all causes (including the usual infantile diseases, accidents, etc.,) were 756,893, so that nearly one in every eight persons that died, was killed by consumption (tuberculosis). But the experience of the New York hospitals showed that a very large percentage of those who died from other diseases had suffered from consumption, so that it will be fair to consider that one in every five persons suffers from tuberculosis. Of course some States are far above that average, and other States, including Utah, are far below the average.

Tuberculosis is a disease that can be prevented. If it can be prevented, it should be prevented, and thousands of human lives saved annually, thereby preventing an untold

* The number of those killed and of those that died from their wounds in the United States Army during the whole of the Civil war of 1861-5, were 110,070 and the annual death rate of the United States Army during those years (killed, died from wounds, and died from disease) did not equal the annual death rate from tuberculosis alone in the United States.
amount of suffering and grief now experienced throughout the world.

By the ordinances of nature the lives of human beings and of animals, act and re-act one upon another. Ignorance and carelessness of man injure cattle and help to predispose them to disease. Diseases of cattle, directly by actual contact, and indirectly by the consumption of the products of diseased cattle, produce diseases in man.

The danger from direct infection of mankind with tuberculosis is, of course, principally limited to those who have charge of horned cattle and those who are frequently in contact with the cattle, or frequently visit infected barns.

Indirect infection is, however, something to which nearly everybody may be exposed. The sources of indirect infection are necessarily the milk and flesh of diseased animals. If germs are found, upon microscopic examination, widely spread in the various organs of cattle, or if they are found in large numbers, the animal must have been in a very advanced stage of disease. The same remark applies to the discovery of many germs in the milk.

Nevertheless it is certain that the bacillus tuberculosis may be present in considerable numbers either in the milk, the blood, the glands, or the muscles, and yet escape ordinary microscopic detection, for it is notorious that it is difficult to detect them. Tuberculosis has frequently been experimentally produced by inoculating animals with the milk taken from a suspected cow, although microscopic examination failed to detect the germs in the milk.

As milk is largely the food of children it is impossible to bestow too much care, so that its purity and freedom from dangerous products may be ensured. I have already stated that the deaths from all causes in 1880 were 756,893, but of that number no less than 302,424 were deaths of children under five years of age. The cause of a very large percentage of those deaths was diseases caused by defective and improper food.

Professor Babes found during eight years experience in the children's hospital at Buda-Pesth that, no matter of
what disease a child may have died, fifty per cent. of post mortem examinations showed tubercles of some of the glands.

Tuberculosis can be conveyed in the flesh of tuberculous cattle, the bacilli being probably most numerous in the juice of the muscles and in the lymphatic glands; but the flesh of pigs afflicted with the disease is far more injurious than that of cattle, as the bacilli are frequently common in the flesh as well as in the glands. Of course if the flesh and the juices are submitted to a sufficiently high temperature in cooking and are well cooked throughout, the danger therefrom is very materially reduced. Some authorities consider that in the early stages of the disease, the meat if well cooked can be consumed with impunity, but the writer considers it desirable to err on the side of safety.

Further the tuberculosis bacilli, in common with most other germs, produce chemical changes in the organisms into which they are introduced naturally or artificially. The chemical changes produced by some germs may be non-injurious, or even beneficial, but in very many cases the germs produce substances that are highly injurious and may produce disease and death. These products of chemical changes are called ptomaines and toxins.

One of the most virulent of these ptomaines is called tyrotoxicon, and was first isolated by Dr. Victor C. Vaughan, Director of the Hygienic Laboratory in the University of Michigan at Ann Arbor in 1885. Tyrotoxicon is a poisonous principle, which is produced in milk and cheese and has been the cause of many cases of poisoning, which have occurred at picnics and festivals from eating ice-cream.

In 1887, at the invitation of Dr. Vaughan the writer accompanied him to see a family residing at Milan in Michigan, a few miles from Ann Arbor. The family consisted of a farmer, his wife and two children, who were attacked, within two or three days of each other, by a disease, the symptoms of which were a flushed countenance, tinged with a purplish hue, dilated eyes, and intense pain in the
abdominal and renal regions, accompanied by great difficulty in emptying the bladder, although the calls were frequent. The temperature was generally low, the pulse frequent, and the breathing much accelerated. Nausea and vomiting were also present, with considerable stupor. Three of the four eventually died. The symptoms pointed to ptomaine poisoning, and after very careful investigations of the surroundings, and analyses of all the articles of food used, it was found that the milk kept in the pantry for twenty-four hours invariably became contaminated with tyrotoxicon, which arose from the introduction into the milk of infectious bacilli that were always present in the pantry. While examining the earth under the floor boards the writer was subjected to considerable nausea and vomiting. Tyrotoxicon was found not only by the chemical tests, but kittens that were fed with the milk, containing the tyrotoxicon, presented all the symptoms of that form of poisoning. No other poisons were found during the investigations of the contents of the stomach and intestines of the deceased persons by Professors A. B. Prescott, and F. G. Novy of the University of Michigan, and the results of the post mortem examinations that were made, showed no other indications that would account for the deaths.

That disease was not tuberculosis, but was produced by germs having entered into the milk supply, increased therein, and produced a poisonous compound which had killed three people, and rendered the father sick nigh unto death.

Tuberculosis germs also produce a ptomaine or ptomaines, which cause fever and a general derangement of the digestive functions. This is evidenced by the wasting and the harsh coat generally present in cases of tuberculosis in cattle. The disease may be acute and rapid in its course or it may make slow progress for many years. A ptomaine produced by the bacilli tuberculosis is Tuberculin, which was manufactured and introduced by Professor Koch in 1890. It was heralded by many physicians and journalists as a cure for consumption, and great results
were expected from its use. The introduction was made by Professor Koch under a governmental pressure that was equivalent to compulsion, and before he had had opportunities of making all the experiments that he desired to make. Unfortunately, its anticipated curative properties were not realized, but tuberculin has become a diagnostic test that renders the detection of tuberculosis in cattle, almost, if not quite, a certainty. By its aid the presence of tuberculosis can be ascertained in its earlier stages, when not even the eye of an expert veterinarian can detect any external symptoms of the disease.

Tuberculin has become an article of commerce, being manufactured by several firms of manufacturing chemists in this country and in Germany. It is also manufactured by the Bureau of Animal Industry of the Department of Agriculture in Washington, D. C.

Tuberculin, as prepared at Washington, is produced by the growth and action of the tuberculosis bacilli in a solution containing glycerine, mineral salts and asparagin—a form of urea. Dr. Schweinitz, the chemist of the Bureau of Animal Industry, thus describes the mode of preparation, after the germs have produced their chemical results.

"After sterilization of the ripe artificial cultures, the germs were removed by filtration, and the mineral salts by dialysis. The addition of absolute alcohol to the dialysed solution, free from mineral salts, produced a white flocculent precipitate. After drying in a vacuum, over sulphuric acid, this was difficultly soluble in water, swelling up, partially soluble in dilute Na O H., insoluble in salt solution. Its water solution yielded a slight opalescence with nitric and acetic acids, and a precipitate with ammonium sulphate. The substance gave the biuret reaction as well as the xanthoproteic, but did not respond to Millon's test. It was free from ash, did not contain sulphur, but phosphorus, the latter combined in the molecule, as it was evident after boiling the substance with nitric acid."

"The precipitate, therefore, would seem to belong to the class of the nucleo-albumins."
"As there had not been a particle of albuminoid matter in the solution, this was purely a synthetical product of the germ life."

The account of this process of manufacture shows that although tuberculin is the product of the germ life, it is purely a chemical substance and is free from germs, as the solution is not only filtered through a germ proof porcelain filter, but is heated sufficiently high and for a sufficient length of time to kill all germs.

The Tuberculin prepared by the Bureau of Animal Industry is in a much more diluted form than that prepared in Germany. The usual quantity to be used for each injection is two cubic centimetres and the injection is made by a hypodermic syringe in the following manner.

On the shoulder, or just in front of the shoulder, the hair should be clipped for about two inches square, and the skin thoroughly washed with a carbolic acid solution of the strength of five parts of carbolic acid to ninety-five parts of water. In such a solution also the hypodermic syringe to be used, should be submerged and thoroughly disinfected for several hours; the hypodermic needle should also be disinfected. Care must be taken that in the needle there is no impediment to the full and free flow of the liquid. Two cubic centimetres of the tuberculin should then be drawn into the syringe, and the needle should be thrust through the skin in a direction pointing towards the ground; the contents of the syringe should then be injected and the needle withdrawn, a light pressure being made upon the region of the puncture for a minute or two, so as to disperse the fluid. Before proceeding to use the needle for another animal it should be again thoroughly disinfected in the carbolic acid solution, and both syringe and needle should be carefully disinfected after all injections have been completed.

Calves and heifers should not receive a full dose of two cubic centimetres, but a quantity somewhat proportional to their age. On the other hand, a bull should receive a larger dose than a mature cow.
If the animal has tuberculosis, its temperature will rise, except under a certain condition to be named hereafter. It will therefore be necessary to have some basis of comparison by which can be ascertained whether the temperature has risen or not. Some investigators have taken the temperature of the animal at different hours of the day for some days previous to the injection, but the system in use here, and which has been found to work well, has been to record the temperature every three hours of the twelve hours immediately preceding the use of the Tuberculin, at the time of injection, and every three hours from the ninth after the injection until the temperature begins to fall again gradually. The temperature may be taken either in the rectum or the vagina, but one or the other must be used exclusively in the same animal. At this station the rectum has generally been used.

The highest temperature is generally reached in from nine to fifteen hours after injection, after reaching which, it gradually falls.

If a second injection be made within a few weeks after the first, there will probably be not any rise in the temperature. Some authorities consider an interval of one month to be sufficient, but probably two or three months will be required to elapse, before the reaction and rise of temperature can be obtained.

The diagnosis by Tuberculin is considered by all, I believe, competent authorities to be unerring, and it certainly points out the presence of the disease when no outward symptoms are visible; but if an animal has tuberculosis in a very virulent form, or is in a very far advanced stage, it is possible that no rise in temperature may follow the injection of the tuberculin. This is accounted for by the presence in the animal of a large number of germs, from which a considerable quantity of ptomaine has been evolved, so that the system has become somewhat saturated with the poisonous compound, and the addition of so comparatively small a quantity as is contained in two cubic centimetres of
the Tuberculin, produces no perceptible addition to the poison, and, therefore, no rise in temperature.

It has been objected that the Tuberculin test may produce tuberculosis in healthy animals. That cannot possibly be done, because as I have already stated the germs that produced the tuberculin have been removed or killed by the combined action of filtration and heating to a high temperature. Inoculation thereby is, therefore, absolutely impossible.

The Experiment Station herd has been drawn from several states, some of which have been found to be, since the purchase of the cattle, severely infected with tuberculosis; others have been purchased from residents of the State of Utah. It was determined therefore to submit the whole herd to a thorough inspection by the Veterinarian and the Associate Professor of Agriculture and further to test with Tuberculin all those that were handed over by them to the Biologist. In conformity with this arrangement four series of injections were made during the past year, and all the animals that reacted to the test by a rise in temperature were killed, and all submitted to autopsical examinations. The result has been that the diagnosis by Tuberculin was amply verified by the autopsies, for in all cases but one, tuberculosis was markedly present. In that one case, the cervical glands appeared to be slightly affected. At the end of this Bulletin are appended tabular statements of the temperatures of the various animals, before and after injection, and concise records of the lesions made manifest in the autopsies.

The physical symptoms of tuberculosis in cattle, when slight or of recent origin are according to Professor Law, the eminent Professor of Veterinary Science at Cornell University, as follows:

"The animal usually falls off in condition. Usually, also, the hair is dry, lustreless and erect in patches, especially along the back. The skin is dry, powdery, and rigid, without its customary mellow touch or mobility on the parts beneath. The eye is less prominent and brilliant; the
breathing is more easily accelerated, the cough is more frequent and easily roused, is often gurgling or rattling and may cause discharge from the nose of a whitish flocculent, sometimes gritty material. The breath is heavy and mawkish. Pinching of the back at the shoulders or loins may cause wincing, groaning, or coughing, as may also pinching above the breast-bone, or striking the ribs with the fingers or fist. Percussion over the ribs reveals spots where there is a lack of resonance, apart from the solid masses of the heart, liver, spleen and stomach, and listening over those spots will detect that variety of morbid sounds familiar to the physician, the most prominent being rubbing, wheezing, creaking, or fine crepitation, mucous rattling and various blowing sounds. A remarkable feature of tuberculosis, distinguishing it from many other forms of lung consolidation attended by unnatural sounds, is the occurrence of such changes in patches, with intervening spaces of sound lung. Ordinary inflammations more commonly attack one portion and spread from that as a centre, extending the solidification in one or all directions. When arriving at this stage, the animal usually fails to make flesh satisfactorily on the best feeding, and milk is not only lessened, but becomes blue, poor and watery."

"The tubercles tend also to form in other organs, notably the lymphatic glands and bowels; and digestion and assimilation being thus seriously interfered with, emaciation advances more rapidly. This advance may be largely accounted for by the fact that the infecting expectorations, brought up with the cough, are largely swallowed to affect stomach and bowels. The animal has now a diminished and capricious appetite, irregular, infrequent, slow rumination and slight bloating after meals. The body temperature is more variable and more frequently high than in slighter forms."

"In the advanced stages of lung tuberculosis every one can recognize the consumptive animal. It is miserably poor, and wastes visibly day by day, the dry coat of hair
stands erect; the harsh scurfy skin clings tightly to the bones; the pale eyes are sunken in the sockets; tears run down the cheeks; a yellowish granular, fetid and, often, gritty discharge flows from the nose; the breathing is hurried and catching; the breath fetid. The cough is weak, painful and easily roused by pinching the back or breast, or striking the ribs. Tapping the ribs with fingers or fist, and applying the ear detect far more extensive changes, including, in many cases, evidences of blowing into empty cavities, and loud gurgling. Temperature may vary from below normal to 107 degrees Fahrenheit.”

The tubercles formed in the internal organs by the bacilli tuberculosis is a whitish or yellowish nodule of cheesy looking material, of variable size and of variable consistency, sometimes soft and sometimes gritty. The nodule in its early stage may not be bigger than a millet seed, but it gradually becomes larger and may become a large mass of nodules attached to the inside of the ribs, and imbedded in the substance of the lungs, liver and other organs. The contents of the nodules may be hard and gritty resulting from the presence of earthy salts, such as lime, or it may be a soft semi-liquid material like the pus of an abscess. The glands throughout the body may be similarly degenerated. Tuberculous sores may also sometimes be found on the skin and mucous membrane (the internal lining of all the cavities of the body) of cattle.

It is probable that tuberculosis is not very prevalent in the State of Utah, but there is a sufficient number of diseased cattle to become a menace to our herds, and through them to the human population. Every effort should, therefore, be used to eradicate the disease and to prevent its being spread from any centers at present producing it.

The Bureau of Animal Industry and other authorities have made suggestions respecting the disinfection and care of barns, the care of cattle, the isolation of those suspected of tuberculosis and the means that should be used to extirpate the disease. Such of those suggestions as have commended themselves to the writer’s mind as likely to be ben-
eficial to the stock raisers of this State have been embodied in the following remarks:

Every owner of cattle should make himself acquainted as much as possible, with the general nature of tuberculosis, and the ways in which infected material may be carried from one animal to another. He should also open every animal of his herd that dies and make himself acquainted with tuberculous growths in the body.

All diseased animals and all suspected animals should be removed from the herd. This is absolutely necessary, otherwise all the other animals will probably be attacked by the disease.

Submit every animal in the herd to the Tuberculin test and do not purchase any animal without first submitting it to that test.

Do not purchase from a herd in which tuberculosis has existed within a year.

Do not purchase a cow that has a rattling cough, wheezing, hurried breathing, discharge from the nose, fetid breath, hard bunches under the skin, diseased udder, swollen bones or joints, unthriftiness, or a tendency to scour or bloat. Cows from city stables and those that have been fed upon swill should be avoided.

The winter months, during which the animals are most confined to the stables and barns, are those in which the greatest diffusion of tuberculosis must be expected. It is therefore most important that the barns should be well ventilated, but at the same time protected from sudden changes of temperature.

The partitions between the stalls should be so boarded up that no two cows can feed from the same manger, or can lick each other.

Each animal should have a regular place in the barn; animals should not be shifted about from one stall to another.

It is better for each animal to have a separate drinking trough, but if any animal is suspected of tuberculosis it
should never be allowed to use the same trough or bucket as the other animals.

Barns should be kept clean and dirt should not be allowed to accumulate.

If any case of tuberculosis has occurred, the barn should be thoroughly cleansed and all dirt removed, after which it should be submitted to a thorough disinfection. If necessary all the wood-work should be scraped so that the disinfectant used may be able to penetrate the wood. The person doing the scraping should protect his mouth and nose to prevent the inhalation of germs.

The disinfectants that may be used are mercuric chloride, carbolic acid and chloride of lime.

Mercuric chloride, also called corrosive sublimate, is a powerful poison, and should be covered up, as well as carefully guarded. The mercuric chloride should be used in a solution of one part in one thousand parts of water, which can be accomplished by dissolving

1 ounce of mercuric chloride in
8 gallons of water.

The water should be placed in wooden tubs or barrels and the mercuric chloride added to it. The whole must be allowed to stand for twenty-four hours so as to allow the chemical to be entirely dissolved. If it should be necessary to use it more quickly, a druggist will dissolve the mercuric chloride in hydrochloric acid, when the acid solution may be added to the water, and the whole used within a short time afterwards. It should be applied with a broom or mop and used freely in all parts of the barn.

Since this solution loses its virtue in proportion to the amount of dirt present, the caution previously given to remove all dirt was necessary. After it has been applied, the barn should be kept vacant as long as possible. Before the animals are allowed to return to the barn, all the wood-work should be washed with water, so that they may not be injured by licking the poisonous material with their tongues.

The carbolic acid solution may be made by dissolving
52 ounces of carbolic acid in
8 gallons of water.
This should likewise be applied to the wood-work and floor
of the barn with a broom or mop.

The chloride of lime solution may be prepared by adding
40 ounces of chloride of lime to
8 gallons of water.
This should be applied in the same way.

Dr. Theobald Smith, of the Bureau of Animal Industry,
recommends the following disinfectant as very serviceable.
It is not poisonous, but quite corrosive, and care should be
taken to protect the eyes and hands from accidental splashing; take

$\frac{1}{2}$ gallon of crude carbolic acid,
$\frac{1}{2}$ gallon of crude sulphuric acid.

These two substances should be mixed in tubs or glass
vessels. The sulphuric acid should be very slowly added to
the carbolic acid. During the mixing a large amount of
heat will be developed. The disinfecting power of the
mixture will be heightened if the amount of heat be kept
down by placing the tub or glass demijohn containing the
carbolic acid in cold water while the sulphuric acid is
being added. The resulting mixture must be added to
water in the proportion of one gallon of mixture to nine-
teen gallons of water.

One gallon of mixed acids will thus furnish twenty gal-
lons of a strongly disinfectant solution, having a slightly
milky appearance, which also should be applied to the barn
with a mop or broom.

Whitewash is not in itself of sufficient strength to destroy
the bacilli, but by imprisoning and encrusting them on the
walls of barns, they are rendered comparatively harmless.
Whitewashing should be preceded by thorough cleansing.

Particular attention should be given to the sides and
ceiling of the barn. All dust and cobwebs should be perio-
dically washed down. Those parts coming into contact
with the heads of cattle, stanchions, halters, troughs, etc.,
should be frequently cleansed and disinfected, even when they have not been used by avowedly diseased cattle.

The removal of virus from barns should be promoted by the prompt removal of manure and by abundant ventilation. Good air has the effect of diluting infected air, and thereby reducing the chance of inhaling floating dried tuberculosis bacilli, or, at least, reducing the number to be inhaled. It likewise improves the vigor of the confined animals and increases their power of resistance to infection.

Cattle should be housed as little as possible. The pasture has the effect of greatly reducing the chances of infection by a more or less rapid destruction of virus, as well as increasing the vigor of the animals through muscular exertion in fresh air. To what extent animals may pick up the virus on fields it would be difficult to estimate. That it is perfectly possible can not be gainsaid. A tuberculous animal may soil the ground over which it passes, and other animals may take up the virus with the food soon after.

It is not likely that the virus remains alive long enough on the ground to become dried and ready for inhalation. The action of sunlight, the alternate wetting and drying which goes on in nature may be looked upon as destructive agents. Even if the tubercle bacilli became speedily dried, the great diluting effect of the open air would reduce to a minimum the chances of inhaling the virus.

Persons afflicted with tuberculosis should not attend on cattle or other live stock in barns. Cattle suffering from that disease may be the means of infecting the persons attending them, if they remain for a long time with the cattle in close, badly ventilated barns. Ventilation, therefore, is a necessity for the human attendant, as well as for the confined cattle. The Department of Animal Industry considers that each cow should have, at least 600 cubic feet of air space. That is certainly not an over-estimate; the writer considers that it would be better to allow a larger cubic space.

All animals that may die from tuberculosis, or that may be killed, because they are afflicted with that disease,
should be burnt, or buried deeply in a place to which animals can not have access.

If there should be rats, or other vermin in a barn that has been infected by tuberculous animals, they should be exterminated.

Pigs, calves, and other animals should never be fed with milk from tuberculous animals, nor from animals suspected of tuberculosis, unless it has been sterilized. Infection, except from those markedly tuberculous, may not be certain, but it is well to remember there is always some amount of danger.

If milk be boiled it will be sterilized, but the boiling also alters the condition of its constituents somewhat, besides affecting the taste. It will, therefore, be better to raise it to a temperature of about 160 degrees Fahrenheit and maintain it at that temperature for twenty or thirty minutes.

It is best, however, not to use milk from tuberculous cows at all.

Appended to this bulletin are tables showing the temperatures, both before and after injection of Tuberculin, of such of the Experiment Station herd as were submitted to the Tuberculin test; also brief details of the results of the autopsical examinations made of those that were killed.

During those investigations I was favored with the hearty co-operation of Dr. S. S. Twombly, the then Professor of Chemistry and Veterinary Science in the Agricultural College of Utah. Professors A. A. Mills and F. B. Linfield, filling the chairs of Agriculture and of Dairying, also kindly accorded me their valuable assistance.

Mr. Christian Larsen, one of the senior students of the College has been kind enough to make the drawings numbered I to V which accompany this bulletin.

It is proposed to issue within the next few months another bulletin on Tuberculosis entering more fully into the details of the work that has been done, and the results that have been obtained in the other States of the Union, and in the various countries of Europe, so that the inhabitants of Utah may have the opportunity of becoming acquainted
with the condition of the disease elsewhere, and the means adopted to limit its spread.

<table>
<thead>
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<th>12 m.</th>
<th>3 p.m.</th>
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</table>

The injections were made immediately after the 6 p.m. temperatures were taken.

Those animals marked R showed the characteristic rise in temperature of two degrees or over.
### TABLE II.

**TEMPERATURE OF CATTLE.**

Before and after injection with Tuberculin, on June 4th and 5th.

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<th>NAME</th>
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</table>

The injections were made immediately after the 6 p.m. temperatures were taken.

Those animals marked R showed the characteristic rise in temperature of two degrees or over.

Mayflower of Woodlawn marked N did not show a similar rise of temperature to that shown on 6th of May; immunity probably the result of previous injection.

Mary Xalapases and Mary Xalapases 29th were mother and daughter.
# TABLE III.

TEMPERATURE OF CATTLE.

Before and after injection with Tuberculin on June 26th and 27th.

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<td>Field Boy ............... N .......</td>
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<td>Effie Dauncey's Calf .... N .......</td>
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</table>

The injections were made immediately after the 7 p.m. temperatures were taken.

Those animals marked R showed the characteristic rise in temperature of two degrees or over. Mary of Xalapas 29th, and Baron Bates show the rise although they were injected on 5th June. Field Boy's temperature rose to within one tenth of the two degrees. Those marked N did not show a similar rise in temperature to that shown on June 5th; immunity probably the result of previous injection.


### TABLE IV.

**TEMPERATURE OF CATTLE.**

*Before and after injection with Tuberculin on October 19th and 20th.*

<table>
<thead>
<tr>
<th>NAME</th>
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</table>

The injections were made immediately after the 7 p. m. temperatures were taken.

Those animals marked R showed the characteristic rise in temperature of two degrees or over. Those marked N did not show such a rise; immunity probably the result of previous injections.

Several of the above named animals, although the diagnostic tests on previous occasions demonstrated the presence of Tuberculosis, had been isolated from the remainder of the herd and kept for further experiments.
AUTOPSICAL MEMORANDA.

It has been considered unnecessary to give the whole details of the results of the postmortem examinations, but extracts have been made only of those parts that had reference to tubercular lesions.

TENIA.—JERSEY COW.

Lungs.—Both right and left posterior lobes showed considerable inflammation. On the left posterior lobe commencing tubercles.

Glands.—Several lymphatic glands showed slight granulations.

MULBERRY EUROTA II.—JERSEY COW.

Lungs.—Both right and left lungs showed a considerable quantity of medium sized tubercles.

Liver.—Was markedly granular.

Glands.—Many of the glands were decidedly tuberculous.

DEVON STEER.

Upon first opening this animal a very general and decidedly tuberculous appearance presented itself.

Lungs.—All the lobes were covered with tubercles of various sizes, some extremely large, and in various stages of degeneration.

Liver.—Enormously enlarged and covered with tubercles.

Both lungs and liver were extensively adherent and the ribs were covered with tubercular growths.
Spleen.—Was very friable and covered with tubercles.
Glands.—In all parts of the body were very tuberculous.

TENIA'S CALF.—JERSEY BULL CALF.

In this calf the parotid lymphatic and a few other glands were the only organs in which tubercles could be found.

BARON BATES OF GLEN ECHO.—SHORT HORN BULL.

Lungs.—Showed considerable inflammation generally, with commencing tubercles on each posterior lobe.
Liver.—Likewise showed some granulations.
Glands.—Parotid lymphatic and a few other glands were slightly tuberculous.

MARY XALAPAS 29th.—SHORT HORN.

Lungs.—Showed tubercles in early stages.
Spleen.—Was also affected.
Glands.—Also disclosed granulations.

MARY XALAPAS.—HEIFER.

Lungs.—Showed considerable inflammation, with tuberculosis in an early stage on the right posterior lobe.
Glands.—Mesenteric and other glands were tuberculous.

MISS RAMSDEN II.—SHORT HORN COW.

Lungs.—Showed considerable inflammation with slight tuberculous development on all lobes.
Glands.—Parotid lymphatic, mesenteric and other glands were distinctly tuberculous.

FIELD BOY.—POLLED ANGUS BULL.

Lungs.—Presented tuberculous development in various stages.
LIVER.—Was extensively granular.
Spleen.—Was also granular.
Glands.—In several parts of the body were much enlarged and granulated.

MAYFLOWER OF WOODLAWN.—POLLED ANGUS COW.

Lungs.—Showed much inflammation, but tuberculosis symptoms were not discernable.
Glands.—Parotid lymphatic and a few other glands showed slight granulations.

FANNY FIELD.—POLLED ANGUS COW.

Lungs.—Commencing tuberculosis in left posterior lobe.
Glands.—Several glands were very distinctly granulated.
Liver.—Three slight spots of granulation.

MYRAMPO St. LAMBERT'S CALF.

Lungs and glands were slightly granular.
EXPLANATION OF PLATES.

I. Section of a lymphatic gland showing Bacilli Tuberculosis.

II. Bacilli Tuberculosis from a culture on glycerin-agar magnified 1000 diameters.

III. Section through a tuberculous nodule in the lung of a cow showing two giant cells containing Bacilli Tuberculosis.

IV. Culture of Bacillus Tuberculosis upon glycerin-agar in a glass test tube.

V. Ventral aspect of a cow's lungs; X shows the usual location of the earliest lesions of tuberculosis in the lung.

VI. Biological Laboratory.

VII. Bacteriological Laboratory of Experiment Station.

VIII. Students at work in the Biological Laboratory of the College.
AT WORK IN BIOLOGY.