(2) The Changes produced by the Tubercle Bacilli.

(*a*) *The Nodular Tubercle.*—The body which we term a "tubercle" *presents in its early formation nothing distinctive or peculiar, either in its components or in their arrangement.* Identical structures are produced by other parasites, such as the actinomyces, and by the strongylus in the lungs of sheep.

The researches of Baumgarten have enabled us to follow in detail all the steps in the development of a tubercle.

These are : ( ) The multiplication of the fixed cells, especially those of connective tissue and the endothelium of the capillaries, and the gradual production from them of rounded, cuboidal, or polygonal bodies with vesicular nuclei—the *epithelioid cells*—inside some of which the bacilli are soon seen.

(*β*) From the vessels of the infected focus, leucocytes migrate in numbers and form the lymphoid cells which were thought to be so characteristic of tubercle. They do not, however, undergo division.

(*γ*) A reticulum of fibres is formed by the fibrillation and rarefaction of the connective-tissue matrix. This is most apparent, as a rule, at the margins of the growth.

(*δ*) In some, but not all, tubercles *giant cells* are formed by an increase in the protoplasm and in the nuclei of an individual cell, or possibly by the fusion of several cells. The giant cells seem to be in inverse ratio to the number and virulence of the bacilli. In lupus, joint tuberculosis, and scrofulous glands, in which the bacilli are scanty, the giant cells are numerous; while in miliary tubercles and all lesions in which the bacilli are abundant the giant cells are few in number.

The bacilli then cause, in the first place, a proliferation of the fixed elements, with the production of epithelioid and giant cells; and, secondly, an inflammatory reaction, associated with exudation of leucocytes. How far the leucocytes attack and destroy the bacilli has not been definitely settled—Metschnikoff claiming, Baumgarten denying, an active phagocytosis.

Once formed, a tubercle undergoes caseation and sclerosis.

Caseation.—At the central part of the growth, owing to the direct action of the bacilli, a process of coagulation necrosis goes on in the cells, which lose their outline, become irregular, no longer take stains, and are finally converted into a homogeneous, structureless substance. Proceeding from the centre outward, the tubercle may be gradually converted into a yellowish-gray body, in which, however, the bacilli are still abundant. No blood-vessels are found in them. Aggregated together these form the cheesy masses so common in tuberculosis, which may undergo (*a*) softening; (*b*) fibroid limitation (encapsulation); (*c*) calcification.

Sclerosis.—With the necrosis of the cell elements at the centre of the tubercle, hyaline transformation proceeds, together with great increase in the fibroid elements; so that the tubercle is converted into a firm, hard

structure. Often the change is rather of a fibro-caseous nature; but the sclerosis predominates. In some situations, as the peritonæum, this seems to be the natural transformation of tubercle, and it is by no means rare in the lungs.

In all tubercles two processes go on: the one—caseation—destructive and dangerous; and the other—sclerosis—conservative and healing. The ultimate result in a given case depends upon the capabilities of the body to restrict and limit the growth of the bacilli. There are tissue-soils in which the bacilli are, in all probability, killed at once—*the seed has fallen by the wayside.* There are others in which a lodgment is gained and more or less damage done, but finally the day is with the conservative, protecting forces—*the seed has fallen upon stony ground.* Thirdly, there are tissue-soils in which the bacilli grow luxuriantly, caseation and softening, not limitation and sclerosis, prevail, and the day is with the invaders—*the seed has fallen upon good ground.*

The action of the bacilli injected directly into the blood-vessels illustrates many points in the histology and pathology of tuberculosis. If into the vein of a rabbit a pure culture of the bacilli is injected, the microbes accumulate chiefly in the liver and spleen. The animal dies usually within two weeks, and the organs apparently show no trace of tubercles. Microscopically, in both spleen and liver the young tubercles in process of formation are very numerous, and the process of karyokinesis is seen in the liver-cells. After an injection of a more dilute culture, or one whose virulence has been mitigated by age, instead of dying within a fortnight the animal survives for five or six weeks, by which time the tubercles are apparent in the spleen and liver, and often in the other organs.

(*b*) *The Diffuse Infiltrated Tubercle.*—This is most frequently seen in the lungs. Only a great master like Virchow could have won the profession from a belief in the *unity of phthisis*, which the genius of Laennec had, on anatomical ground, announced. Here and there a teacher, as Wilson Fox, protested, but the heresy prevailed, and we repeated the striking aphorism of Niemeyer, "The greatest evil which can happen to a consumptive is that he should become tuberculous." It was thought that the products of any simple inflammation might become caseous and that ordinary catarrhal pneumonia terminated in phthisis. It was peculiarly fitting that from Germany, in which the dualistic heresy arose, the truth of Laennec's views should receive incontestable proof, in the demonstration by Koch of the etiological unity of all the various processes known as tuberculous and scrofulous.

Infiltrated tubercle results from the fusion of many small foci of infection—so small indeed that they may not be visible to the naked eye, but which histologically are seen to be composed of scattered centres, surrounded by areas in which the air-cells are filled with the products of exudation and of the proliferation of the alveolar epithelium. Under the influence of the bacilli, caseation takes place, usually in small groups of