ON THE

MINUTE STRUCTURE

AND

CHEMICAL COMPOSITION

OF

TUBERCULAR DEPOSITS.

BY

JOHN HUGHES BENNETT, M.D., F.R.S.E.,

LECTURER ON THE PRACTICE OF PHYSIC AND ON CLINICAL MEDICINE, PATHOLOGIST TO THE ROYAL INFIRMARY, EDINBURGH, &c. &c.

EXTRACTED FROM THE

NORTHERN JOURNAL OF MEDICINE FOR APRIL AND MAY 1846.

PRINTED BY HUGH PATON, EDINBURGH.

ON THE

MINUTE STRUCTURE AND CHEMICAL COMPOSITION

OF

TUBERCULAR DEPOSITS.

On opening the bodies of those who die labouring under scrofula, one or more organs are found to contain a foreign matter, which has universally received the name of *tubercle*. The term tubercle is of Latin derivation, and literally implies a little swelling. In this sense it is still used by dermatologists, and serves to distinguish a class of skin diseases. The same name was unfortunately applied to the rounded masses so frequently found in the lungs or other organs. It has also been employed to characterize the same substance when infiltrated in masses, or under circumstances where its original signification cannot apply. At present, tubercle is generally considered to be a peculiar morbid deposit, sometimes grey, but more frequently of a yellowish colour, varying in size, form, and consistence, which sooner or later undergoes a process of softening.

This definition of tubercle is very vague, and may be applied to various kinds of exudation which materially differ from each other. Indeed every morbid anatomist must frequently have experienced much difficulty in endeavouring to determine by the naked sight whether a certain morbid deposit be or be not tubercle. With a view to establishing a correct pathology therefore, our first efforts must be directed to determine what tubercle really is; how it can be accurately separated from the ordinary products of inflammation on the one hand, and from malignant or other morbid growths on the other. To arrive at these points we must inquire into the minute structure and chemical constitution of this substance.

Minute Structure of Tubercle.

If from the tubercular lung of an individual who has died from phthisis pulmonalis, we choose a small mass of tolerably firm consistence, make a thin section of it, slightly press it between two slips of glass, and examine the whole with a power of 250 diameters linear, we shall observe an appearance similar to that represented in Fig. 1. The network of the lung (*a*), constituted of filamentous tissue, preserves its natural appearance and arrangement. The intermediate spaces or cells of the organ, however, are filled by a dense granular matter (*b*), the constituents of which are so closely aggregated together, that their form and character cannot be examined.

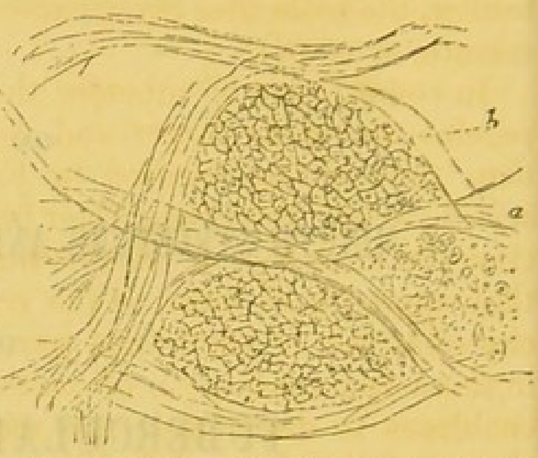

Fig. 1. Section of a miliary tubercle in the lung, (a) filamentous tissue of the lung, (b) corpuscles of tubercle.

If we add a drop of water to the section, and use slight pressure with the upper glass, so as to squeeze and wash out the granular contents, we shall find the fluid loaded with corpuscles and granules as represented in Fig. 2. The corpuscles are of an irregular form, more or less angular, varying in their longest diameter from $\frac{1}{50}$ to $\frac{1}{100}$ of a millimetre, composed of a distinct wall, containing generally three or more granules, without any distinct nucleus. They are mixed with numerous granules and molecules, varying in size from a point scarcely measurable, to the $\frac{1}{500}$ of a millimetre in diameter.

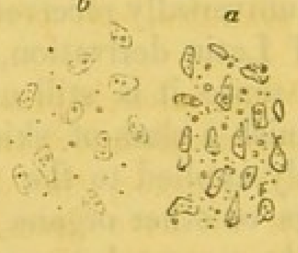

Fig. 2. Corpuscles of miliary tubercle from the lung, (a) as washed out with water, (b) after the addition of acetic acid.

If, now, we add to this fluid a drop of weak acetic acid, all the corpuscles become more transparent, but are otherwise unchanged, and many of the granules disappear, as in Fig. 2 (*b*). Ether and alcohol produce little change. Ammonia partially dissolves the corpuscles and renders them capable of being easily broken down. They are immediately and completely dissolved in a solution of potash.

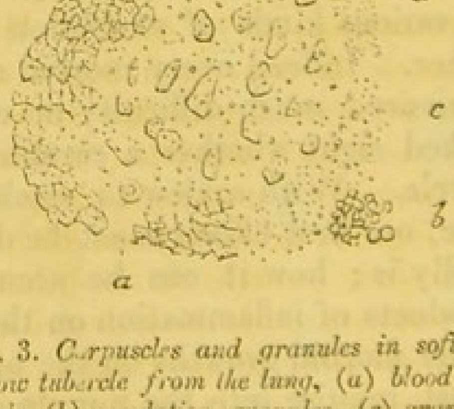

Fig. 3. Corpuscles and granules in softened yellow tubercle from the lung, (a) blood corpuscle, (b) exudation granules, (c) granular matter, (d) molecular matter.

Again, if we simply squeeze a portion of soft yellow tubercle between glasses, and examine it with a like magnifying power, we shall see similar corpuscles and granules, as in Fig. 3, mixed perhaps with a few blood corpuscles (*a*) and exudation granules, (*b*).

Sometimes softened tubercle seems partially or wholly composed of a granular matter, (*c*). At others, we only observe it to be molecular, the molecules being exceedingly minute, as at (*d*).

In some forms of tubercle the corpuscles are much larger and rounder than they are represented in Fig. 2, still however preserving their peculiar character as in Fig. 4. In this manner, they approach in form to the corpuscles observed in scrofulous pus. But in those the application of acetic acid enablesus to distinguish the nucleus, characteristic of pus globules.

Fig. 4. Rounded and larger corpuscles in tubercle, from a bronchial gland.

The grey semitransparent granulation is of semicartilaginous hardness, and presents to the eye a very different appearance from ordinary tubercle. On making a thin section of it, however, it will be found to be composed of similar elements, although more transparent and not so well defined. The addition of acetic acid, by rendering the fibrous tissue more transparent, and dissolving the granules, will permit the same structure to be seen, as in Fig. 1.

When tubercle presents the cretaceous orcalcareous transformation in any degree, the different elements we have described become mixed up with hard gritty particles of earthy salts. These are of irregular form and size, and are larger and numerous in proportion as the tubercle is more and more calcareous. Crystals of cholesterine may also frequently beseen in cretaceous concretions—(Fig. 4. *a.*) When tubercle is converted into a mass of stony hardness, a thin section presents a granular appearance, made up of a congeries of minute earthy particles, without any distinct form.

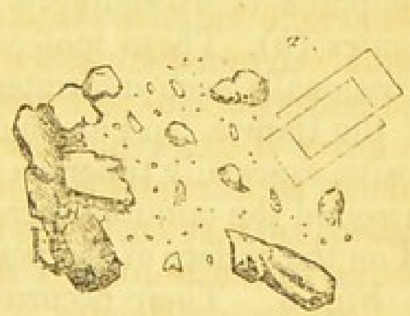

Fig. 5. Earthy matter, and tubercle corpuscles in a cretaceous concretion from the lung, (a) crystals of cholesterine.

Numerous instances occur in which it is utterly impossible to distinguish tubercle from fibrinous exudations on the one hand, or cancerous growths on the other, except by paying attention to the minute structure now described. I have often been deceived in endeavouring to determine this by naked sight, and found on a microscopic examination, that so called tubercular masses were composed of filaments, more or less mixed up with plastic or granular corpuscles. Again, not unfrequently tubercle has been mistaken for cancer, or the latter for the former. If then we are asked to determine what is positively tubercle, as distinguished from all other morbid products, we must answer, that deposition which is composed of the peculiar corpuscles and granules formerly described and figured. From pus corpuscles they are readily distinguished by the action of acetic acid, which in them causes no granular nucleus to appear. From plastic corpuscles they may be separated by their irregular form, smaller size, and the absence of primitive filaments. With the exudation or granular corpuscle they can scarcely ever be confounded, on account of its large size, brownish or blackish colour, and nucleated or granular structure. The cells of cancer are large, transparent, and distinctly nucleated, and consequently easily distinguished from the small, non-nucleated corpuscles of tubercle.

There are certain fibrinous exudations, granular throughout, which it is very difficult to separate from the granular form of tubercle. This, indeed, can only be done when the granules in the one case are associated with inflammatory, and in the other with tubercular corpuscles.

We frequently find tubercle conjoined with more or less pigmentary matter. This usually appears under the microscope in the form of irregular black masses, (Fig. 6. *a*), which are composed of exceedingly minute molecules (*b*). These molecules may be occasionally seen infiltrated into many of the tissues, and among morbid deposits, especially tubercle. They often surround the minute tubercles deposited on the surface of the peritoneum, as in Fig. 6. Their occurrence in considerable masses is almost uniform, around chronic tubercle in the lung or bronchial glands, giving a black or blueish tinge to the tissues. Indeed, it may be said that the older the tubercle the greater is the amount of pigmentary matter surrounding it.

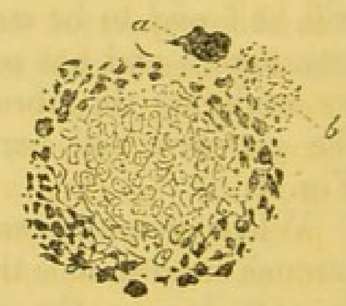

Fig. 6. Corpuscles mixed with pigmentary matter, in a small tubercle taken from the peritoneum, (a) irregular masses of black matter, which may be broken down into (b) granular and molecular matter.

Tubercle is often sought for and found in the sputa of phthisical persons. In such cases it resembles the softened masses, represented in Fig. 3. Inexperienced histologists are peculiarly liable to confound the corpuscles of tubercle with those of pus, or of the epithelium. I have even known the broken down grains of starch, pieces of bread, and other substances, which find their way into a spit-box, confounded with tubercle. A microscopic examination of the sputum, indeed, demands a most extensive knowledge of both animal and vegetable structure. I have found in it, 1st, all the structures which enter into the composition of the lung—such as filamentous tissue, young and old epithelial cells, blood corpuscles, &c. 2dly, Morbid growths, such as pus, plastic, and granular cells; tubercle corpuscles, granules, and amorphous molecular matter; pigmentary deposits of various forms, and parasitic vegetations which occasionally are found in the lining membrane of tubercular cavities. 3dly, All the elements that enter into the composition of the food, whether animal or vegetable, which hang about the mouth or teeth, and which are often mingled with the sputa, such as pieces of bone or cartilage, muscular fasciculi, portions of esculent vegetables, as turnips, carrots, cabbages, &c.; or of grain, as barley, tapioca, sago, &c.; or of bread and cakes; or of fruit, as grapes, oranges, &c. &c. All these substances render a microscopic examination of expectorated matters in phthisis any thing but easy to the student.

After considerable experience in the examination of sputa, I think myself warranted in saying, that a knowledge of its minute structural composition is of little use in a clinical point of view. The diagnosis of phthisis in its various stages, is capable of being so accurately determined by auscultation, that the microscope is in this respect of secondary importance.

From what has preceded, it must be evident that tubercle presents different appearances, according as it is hard or soft, cretaceous or calcareous. When recent and hard, the corpuscles are crowded together, and the granules accompanying them are comparatively few in number. When soft, the number of granules is much increased, and the corpuscles are easily separated. Lebert[1] is of opinion that at first the corpuscles are kept together by an intermediate substance, which afterwards softens. We can only regard this interglobular substance as the blastema in which the corpuscles are formed. The softening, then, is more probably owing to the development and breaking down of the latter, similar to what we observe in inflammatory exudations generally.

Gulliver[2] and Vogel[3] agree in saying, that at an early period, more especially when in a miliary form, nucleated cells may be observed in tubercular matter. This is denied by Lebert, and I must confess that I have never been able to discover nuclei in the corpuscles of tubercle. They appear to me to be undeveloped cells, which are produced slowly and have no tendency to form perfect organizations, before they break down into a molecular matter. Hence no danger is to be apprehended from the spread of tubercle itself, and if fresh deposits could be prevented, the tendency of this substance to disintegration, is highly favourable to its absorption.

Great disputes have taken place with respect to the vascularity of tubercle. Numerous successful injections I have made have

---

[1] Physiologie Pathologique, p. 527—et seq.

[2] Gerbers' Anatomy—appendix, p. 85.

[3] Icones' Histologiæ Pathologicæ, tab. 4.

invariably shown the non-vascularity of this formation. It is true that in large tubercular masses, and in tubercle infiltrated to any extent through a parenchymatous tissue, vessels are not unfrequently found. These, however, belong to portions of cellular tissue, which have been imprisoned in the exuded mass. So long as pathologists imagine that naked sight is sufficient to unfold morbid structure, they must necessarily be led into error.

On the Chemical Composition of Tubercle.

Dr Abercrombie[1] showed that a mass of tubercle, on being plunged into boiling water, contracted, and became more dense and firm, when it presented all the characters of coagulated albumen. This was well observed in the mesenteric glands, which, when only slightly affected, lost a considerable amount of their weight. This loss became less and less as the tubercular deposition increased, until at length the whole gland appeared to be converted into solid coagulated albumen, and scarcely lost any of its weight by boiling.

Dr Abercrombie observes, " the deposition of albumen, therefore, in these glands, appears to be a process of disease. In the early stages of the disease, it seems to be deposited in a soft state, and to be involved in the structure of the gland ; the gland in other respects being vascular and organized, and probably capable of performing its functions. It is in this state that we see the albumen coagulated, when the gland is plunged into boiling water, producing so immediate and remarkable a change in its appearance and texture. As the disease advances, the proportion of albumen seems to increase, while at the same time it assumes a more concrete state, and the mass in general becomes less vascular and less organized. In the last stage, the vascular structure of the gland seems more and more to disappear, until it passes into a mass presenting the properties of coagulated albumen, with little or no organization."

Dr Abercrombie further pointed out that the tubercular disease of the peritoneum presented characters very different from that of the lungs or lymphatic glands. By boiling in water, the tubercles were nearly dissolved, leaving only a small central part to which they seem to have been attached, and which had undergone little or no change during this first boiling. The part that was dissolved seemed to consist entirely of the muco-extractive matter, and the part that remained appeared, on further examination, to be the same substance in a more concrete form, with a small trace of albumen.

According to the analysis of M. Thénard,[1] 100 parts of pulmonary tubercle, not softened, contained

---

[1] Medico-Chir. Transactions of Edin. vol. i. p. 687. 1826.

Animal matter		98·15
Muriate of soda	}	1·85
Phosphate of lime		
Carbonate of lime		
Oxide of iron		a trace.

Other tubercles which had undergone the cretaceous transformation, presented the inverse proportions; that is to say, in 100 parts

Animal matter	3
Saline matters	96

Lobstein[2] gives at length the process which the younger Hecht followed, in analysing, at his request, a portion of crude tubercle. He found six grammes of dense tubercular matter gave

Albumen	1 gramme	4 décigrammes.
Gelatine	1 "	2 "
Fibrine	1 "	8 "
Water and loss	1 "	6 "
	6 "	0 "

Lassaigne[3] made a comparative analysis between the tubercles of the lungs, and of the liver, in a horse. He found

	Tubercle of Lung.	Tubercle of Liver.
Animal matter	40	50
Sub-Phosphate of lime	35	45
Carbonate of lime	9	4
Salts soluble in water	16	1
	100	100

He points out that the animal substance is not transformed into gelatine by coction, but rather exhibits the properties of coagulated albumen.

The analysis of pulmonary tubercle of a child 2 years old, by Preuss,[4] was very carefully made. In ten parts of the diseased pulmonary substance, he found

Water	79·95
Tubercular matter	13·52
Fibrous residue, vessels, bronchi, &c.	6·53
	100·00

a. The fibrous residue was composed of

Fat	4·13
Substance furnishing glue by coction	20·67
Substance not furnishing glue by coction	75·20
	100·00

[1] Andral. Precis d'Anatomie Pathologique, t. i. p. 417. 1829.

[2] Dupuy, Journal Prat. de Med. Veterenaire, 1838, p. 98.

[3] Traité d'Anatomie Pathologique, 1829, t. i. p. 378.

[4] Tuberculorum pulmonis crudorum analysis chemica. Dissert. Berol, 1835.

b. The tubercular matter contained

1. *Substance soluble in boiling alcohol.*

Cholesterine	4·94

2. *Substances soluble in cold alcohol, but not in water.*

Oleate of soda	13·50
A peculiar substance, Muriate of soda, Lactate of soda, Sulphate of soda	8·46

3. *Substances soluble in water, but not in alcohol.*

Caseine, Muriate of soda, Sulphate of soda, Phosphate of soda	7·90

4. *Substances insoluble in alcohol, and in water.*

Caseine, altered by heat, Oxide of iron, Phosphate of lime, Carbonate of lime, Magnesia, Sulphur	65·11
	100·00

Gueterboeck[1] found in the tubercular ganglions of the neck, of the bronchi, and in pulmonary tubercles—1. Albumen in small quantity. 2. Pyin, different from caseine. 3. Phymatine, a species of osmazome, which, according to him, is proper to tubercles. It is soluble in water and in alcohol; it is precipitated from the solution by acetate of lead, but not precipitated by the extract of gall nuts, nor by a solution of sulphate of copper. 4. Fat, not only of cholesterine, but also fat capable of saponification.

An analysis made by Wood, gives[2]

Substances soluble in ether	3·18
Substances soluble in cold alcohol, and not in water	9·24
Substances soluble in cold alcohol, and in water	10·66
Substances soluble in water, not in alcohol	9·14
Substances insoluble in ether, in water, and in alcohol	67·78
	100·00

Simon[3] analysed tubercle from a horse. It was deposited in masses, from the size of a nut to that of a pigeon's egg; it varied from a yellow to a flesh colour, and its consistence was such as to admit of its ready division by the knife. Internally it was green, and resembled coagulated caseine. It was composed of

Water	84·27
Fat, containing cholesterine	1·40
Alcholic extract with salts	1·52
Caseous matter with watery extract	1·14
Watery extract and salts	3·80
Insoluble constituents	4·44

[1] De pure et granulatione. Berol, 1837.
[2] De puris natura atque formatione. Berol, 1837.
[3] Animal Chemistry, 1842. Trans. by Day, 1846, vol. ii. p. 478.

Scherer[1] has given some very careful analyses of various kinds of tubercle. In each case he has described the general appearance of the mass, and its minute structure, points in which it would be well if all other chemists would imitate him.

Scrofulous tubercle from the mesenteric glands of a child, is thus described. The mass is of a yellow colour, soft consistence, not fibrous, but rather of a fatty granular structure. In the centre of each swelling is a softer and whiter nucleus. Under the microscope were seen nuclei, granules, and nucleated cells, but no fat globules. When triturated with water, a milky fluid was procured, which, after standing some time, deposited a flocculent, granular sediment. The supernatant fluid, after filtration, gave a clear fluid, which, after standing 24 hours in the air, became hazy, and separated molecular granules. It contained albuminate of soda, but on the other hand, no caseine or pyin. When the residue not soluble in cold water, is boiled, a trace of pyin is detectable in the fluid. Boiled with spirits of wine, a yellow extract s obtained, and with alcohol and ether, a tolerable quantity of at, namely elaine.

1000 parts of the fresh mass removed from the body gave

Water	776·78
Solid residue	223·22
Inorganic constituents	5·26

The last were composed of a little chloride of sodium, much arbonate of soda, alkaline phosphates and sulphates, much caronate, and a little phosphate of lime.

The mass purified with boiling water, alcohol, and ether, ielded by elementary analysis, in two analyses :—

Carbon	54·125	
Hydrogen	7·281	
Nitrogen	15·892	16·086
Oxygen	22·702	

Upon the basis of the formula of protein, and the assumption f an equal amount of carbon, as the ground-work of calculation, ıe analysis leads to the following formula,—C 48, H 78, N 12, 15, or protein + H 2, O + H 4 : or calculating from the azote, 46, H 76, N 12, O 12, = protein—C 2, O 2, + H 4.[2]

The second analysis is of tubercular deposition from the right emisphere of the brain of an individual 27 years of age, who had rmerly laboured under scrofula, and latterly chronic tubercle in ıe lungs. The mass was externally reddish, internally yellowish-ey, elastic, and without organization. The substance of the ain surrounding the deposit was softened. Triturated with ater, a turbid milky fluid was procured, which exhibited under

[1] Jahresbericht von Canstatt, 1844. Leistungen in der Pathologischen Chemie von herer.

[2] The original numbers used by Scherer are here given. It will be, of course, nessary to divide those representing H and N by two, to render the equivalents analaus with those used by British chemists.

the microscope, drops of oil, and numerous nuclei and granules. Perfectly formed cells were not seen. The filtered fluid contained less pure albumen than albuminate of soda.

The organic substance cleared from albumen by maceration in solution of nitre, and purified by boiling in water, alcohol, and ether, yielded on an elementary analysis

Carbon	54·410
Hydrogen	7·147
Nitrogen	16·366
Oxygen	22·077
	100·000

Calculated with protein, and assuming the same amount of azote, the following formula results: C 46, H 74, N 12, O 14, or assuming an equal amount of carbon, it gives C 48, H 77, N 12·5, O 15.

The third analysis is of tubercular deposits from the liver of an individual aged 67 years, in whom similar deposits existed in other parts of the body.

The deposits presented externally the consistence and structure of fibro-cartilage. The liver was in a state of cirrhosis. The mesenteric glands were normal. The lumbar glands, on the other hand, were infiltrated with the morbid deposit, a portion of it even was found in the substance of the psoas muscle.

A microscopic examination of the compact white deposit in the liver, exhibited round irregular nucleated cells, with granules, also caudate cells with numerous free granules.

1000 parts yielded

Water	826·04
Solid residue	173·96
Fat taken up by ether, consisting of olein and margarin	18·63
Alcoholic extract	21·75
Watery extract with very slight traces of pyin	8·24
Insoluble organic substance	120·34
Fixed salts	4·90

The insoluble portion contained, afterbeing carefully cleansed with a solution of nitre, alcohol and ether, upon an elementary analysis

Carbon	54·554
Hydrogen	7·121
Nitrogen	16·928
Oxygen	21·397
	100·000

Calculating from the formula of protein, and from an equal amount of azote, we obtain the formula, C 45, H 72, N 12, O 13; calculating from carbon, we have C 48, H 76, N 13, O 14.

The fourth analysis is of tubercular depositions, found in the abdomen of an individual, aged 23 years, of phthisical habit, in whom were also in the lungs old and crude miliary tubercles. The principal deposition was in the adherent loops of the alimentary canal, in which grey, cheesy, greasy masses were found, occupying the seat of the mesenteric glands, and varying in size from a lentil seed, to that of a pigeon's egg. The stomach, as well as the small intestines, were perforated by the deposited new formation, which when felt resembled a purulent diffluent matter.

On the serous covering of the spleen, similar miliary tubercles were found, and on the peritoneal covering of the liver, a layer of plastic exudation 1½ lines in thickness.

The tubercular masses exhibited, under the microscope, besides a large quantity of nuclei, partly broken down cells, and a considerable number of peculiar, fibrous-like branched formations, which resembled nervous tubes. The masses possessed a very offensive odour, evolved ammonia, and gave, when triturated with water, a turbid fluid, with a broken down grey sediment.

1000 parts of the fresh substance yielded

Water	893·32
Solid residue	106·18
Fat	25·40
Caseine and alcoholic extract	12·39
Pyin and watery extract	6·19
Salts	7·43
Crude tubercular matter	54·55

which yielded in three analyses

Carbon	55·299	55·069	55·137
Hydrogen	7·098	7·004	6·944
Nitrogen	16·698	16·534	16·476
Oxygen	20·905	21·393	21·443
	100·000	100·000	100·000

Compared with protein, and calculated from the same amount of azote, we have the formula, C 46, H 72, N 12, O 13 : and from the same amount of carbon, C 48, H 75, N 13, O 14.

The exudation mass covering the peritoneal surface of the liver, gave, digested with solution of nitre, much fluid albumen and caseine. It contained, however, relatively, less extractive matter and fat, than the tubercular masses.

1000 parts yielded

Water	731·62
Solid residue	268·38
Fat	15·47
Watery extract with pyin	4·32
Alcoholic extract with caseine	6·23
Salts	5·40
Insoluble organic substance	237·96

The insoluble organic substance yielded, by elementary analysis

Carbon	55·190
Hydrogen	7·186
Nitrogen	16·602
Oxygen	21·022
	100·000

This substance is consequently identical in composition with the tubercular masses found in the glands. Crude tubercular masses from the lungs yielded little fat, and extractive matter, and on elementary analysis, yielded the following result:—

Carbon	53·884
Hydrogen	7·112
Nitrogen	17·237
Oxygen	21·767
	100·000

which gave the following formula:—

Calculated in relation to carbon = C 48, H 78, N 13, O 15.
„ „ nitrogen = C 43, H 70, N 12, O 13.

According to M. Felix Boudet,[1] tubercles of the lung, in a state of crudity, contain albumen; caseine; matter having the character of fibrine; matter soluble in boiling alcohol, (cerebric acid); oleic and margaric acids; saponifiable fat; lactic acid; lactate of soda; cholesterine 0·045, say $\frac{1}{20}$ of the weight of dry tubercle. The ashes contain soluble salts, the chloride and sulphate of soda, insoluble salts, phosphate and carbonate of lime; silica, and oxide of iron.

The tubercles of the bronchial and mesenteric glands presented a similar composition.

Tubercles of cheesy consistence had an alkaline reaction. Treated with water they furnished a solution partly coagulated by heat. After the separation of the albumen, a liquid remains, in which a precipitate is formed on the addition of acetic acid, as in the milk, and which, evaporated at a gentle heat, gives rise to follicles similar to those which are produced on this latter liquid.

In order not to have any doubt of the identity of this matter with caseine, M. Boudet precipitated comparatively, by means of acetic acid, a certain quantity of cow's milk, and of the liquid obtained from tubercles.

The two precipitates, placed in contact with carbonate of barytes, in order to saturate the excess of acid, then with water, gave two liquids perfectly identical in all their properties. Thus the expression caseous tubercles, founded at first on a simple appearance, is completely justified by chemical analysis.

In crude tubercle, caseine exists in an insoluble state, but by the progress of disease, it is transformed into soluble caseine, under the influence of a certain quantity of ammonia, which is produced under the same circumstances.

M. Boudet states that what is called calcareous tubercle, is composed in reality of a very feeble proportion of phosphate or carbonate of lime, but on the contrary contains nearly 70 per cent of soluble salts, that is, the chloride of sodium, sulphate, and phosphate of soda. It is difficult to conceive, he observes, how a

[1] Bulletin de l'Acad. Roy. de Medecine, t. ix. p. 1163.

mass of soluble salts should thus remain in an organ abundantly supplied with fluids.

Dr Wright[1] of Birmingham, has made many analyses of tubercle, and found its chemical composition to vary, in different specimens, of softened or cheesy tubercle. He gives the two following analyses as the mean of his investigations :—

Fatty matter with oil globules		15·9
Gelatine		6·4
Phosphates, Sulphates, Muriates	Lime, Soda	11·2
Carbonate of lime		a trace
Oxide of iron		a trace
Albuminous matter with fibrin		65·2

Fatty matter with oil globules		7·4
Gelatine		11·8
Phosphates, Sulphates, Muriates	Lime, Soda	2·5
Albuminous matter		76·9

He denies the correctness of M. Boudet's statement, regarding the large amount of soluble salts in cretaceous tubercle.

Such I believe are all the analyses of tubercle hitherto published. It will be seen that they differ materially from each other, and that further researches are necessary. It was with much pleasure, therefore, I heard last spring, from my friend Dr Glover, lecturer on chemistry, at Newcastle, that he was anxious to make investigations into the chemical composition of tubercle. At his request I furnished him with many specimens of this morbid deposit in all its forms ; and I now publish the note he has been so good as to furnish me with, giving the result of his inquiries.

" Many attempts have been made by chemists, to ascertain the constitution of tubercle, and to compare the composition of this formation with that of other morbid structures. The great difficulty in the way of such investigation is the exceedingly imperfect state of the means that we possess of recognizing differences in the various forms of organization by chemical means, and between the different proximate chemical constituents of the tissue ; that is between fibrin, caseine, and albumen.

" In the researches which have hitherto been made on the subject, the difficulties have been too lightly estimated. We find constituents, as caseine and gelatine, set down as existing in tubercle on grounds altogether too trivial to warrant such a conclusion. After numerous investigations, I have never been able to convince myself, that either of the substances mentioned, exist in tubercle, although I am not unwilling to believe that the albumen

[1] Medical Times, vol. ii. pp. 418-9.

found may approach towards the nature of caseine. Perhaps the most striking fact which chemistry developes with regard to this subject, is the large quantity of fat existing in tubercle. This observation my analyses confirm. I have also found pyin in appreciable quantity. My analyses completely contradict the observation of M. Boudet, concerning the large quantity of soluble salts found by him in cretaceous tubercles.

" With regard to the ultimate analysis of the residual albuminous substance of tubercle, or what remains of the mass after the removal of the various fats and extractive matters, I do not find it differ much from the standard composition of protein.

" I shall now give the following analysis :—1000 parts of fresh mesenteric tubercle carefully freed from membrane was dried. This operation gave

Water	803
Solids	197

" The solids contained 16 grains of watery extract, composed of pyin, a muco-extractive matter, and a peculiar extract. The extract and fats (principally the latter), removed by alcohol and ether, weighed 44·9 grains. They were sent to Giessen, for analysis there ; and the results have not yet been sent me. There were also 4 grains of spirit of wine extract.

" The ultimate analysis of the residue gave

Carbon	54·97
Hydrogen	4·43
Azote	12·31
Oxygen	26·09

" This is the smallest quantity of azote which was obtained from such a residue. In another analysis of mesenteric tubercle, the result was 15·56 of azote. I infer, that in the present state of our knowledge, no important inference can be drawn with regard to the difference between the albuminous basis of tubercle, that of lymph, (which I have also examined) and ordinary albumen.

" The following is another analysis of mesenteric tubercle :—

Water	812·5
Solids	187·5

" In 200 parts of the fresh mass, were

Fats		7·50
Extracts soluble in spirit of wine and water		1·76
Salts	Chlorides	0·45
	Earthy salts (phosphates)	0·58
	Alkaline salts	0·50
Protein residue		21·72
		37·50

" The following is an analysis of pulmonary tubercle—a mass of crude tubercle from the lungs of a woman who died of phthisis, which weighed 500 grains, was selected on account of the completeness of the tuberculization. On being dried, the weight was 106·8, giving thus

Water	786·4
Solid residue	213·6
	1000·0

The fats and substances soluble in ether and alcohol were removed, and weighed with their salts 18·25 grains. They were examined qualitatively, and appeared to consist chiefly of elaine, with some cholesterine. The watery extract = 6·55 was not found to contain either caseine or pyin. The spirituous extract and loss amounted to 4·00. The insoluble protein residue was 78·00 grains, 20 grains of this burnt gave 0·4 of ash, or 2 per cent. This residue consisted chiefly of insoluble salts.

"The proximate analysis therefore gave

Fats and extractive substances by alcohol and ether, with salts	18·25
Alcoholic extract and loss	4·00
Watery extract and salts	6·55
Protein residue and salts	78·00
	106·80

"The ultimate analysis of the protein residue gave without ash

Carbon	53·43
Hydrogen	6·64
Nitrogen	14·02
Oxygen	25·91

"The following is an analysis of some tubercles in the intermediate stage of cretaceous transformation sent me by Dr Bennett. Dried they gave

Animal matter	24·80
Salts	9·00
	33·80

"The salts were composed of

Chlorides, chiefly alkaline	1·20
Other salts, soluble in water	1·90
Phosphate of lime	5·40
Carbonate of lime, a trace and loss	0·48
	9·00

"The following is an analysis of some cretaceous masses from the lung, sent me by Dr Bennett, and by Dr Charlton of this town:—

30·1 grains of the concretions dried, gave

Animal matter	7·7
Salts	22·4
	30·1

" The salts were

Phosphate of lime	16·45
Carbonate of lime	5·10
Soluble salts and loss	0·85
	22·40

" This composition is not very dissimilar to that of bone. I have not had time to make the analysis of a curious mass from the bronchial glands sent me by Dr Bennett, and closely resembling putty.

" My analysis of blood in scrofula confirms the fact of the deficiency of blood globules in this disease, along with a corresponding excess of solids of the serum.

" In the urine, the results which I have obtained were chiefly negative.

" Robt. M. Glover."

12 Northumberland Street,
Newcastle, 2d April 1846.

In reviewing the different analyses of tubercle which have now been given, we find—

1st, That tubercle consists of an animal matter, mixed with certain earthy salts.

2d, That the relative proportion of these varies in different specimens of tubercle. That animal matter is most abundant in recent and earthy salts in chronic tubercle.

3dly, That the animal matter certainly contains a large amount of albumen. Some chemists have also detected caseine, the existence of which is probable ; others gelatine, the presence of which is more doubtful. The statement of Gueterboeck, that it contains a peculiar animal matter (phymatine) has not been confirmed by other analysts. Fibrin and fat exist in small, but variable proportion, as a constituent of tubercle.

4thly, The earthy salts are principally composed of the insoluble phosphate and carbonate of lime, with a small proportion of the soluble salts of soda. The statement of Boudet, that cretaceous concretions are principally formed of the latter, is directly opposed by other chemists, and is quite incompatible with their long persistence in the body.

5thly, That very little difference in ultimate composition has yet been detected between recent tubercle, and other so-called compounds of protein.

The two problems which the pathologist wishes the chemist to resolve are, 1st, What difference exists between tubercle, lymph, and cancer? 2dly, Does the blood undergo any change which bears a relation to the production of these deposits? These questions are not yet answered ; but there is every reason to hope, now that attention is directed to these subjects, some thing positive will soon be ascertained. No doubt, there are great difficulties to be surmounted. Organic chemistry is yet in its infancy. Only lately, Reichenbach discovered sulphur in considerable quantity, as a constituent of animal bodies. Even now, the existence of protein, which promised to facilitate our knowledge of organic compounds, has become a subject of dispute. At the last meeting of the Royal Society of this city, (April 6, 1846,) Dr G. Wilson showed that the fluoride of calcium, which had hitherto been considered insoluble in water, was, on the contrary, soluble to a considerable extent. He detected it in recent and fossil plants and animals, in the blood, and in milk. If, then, the very basis of organic analysis is thus uncertain ; if we are as yet ignorant of the chemical constitution of the animal solids and fluids in a state of health, we need not feel surprise at the little assistance pathology has hitherto received from the chemist. We anticipate, however, from the labours of those who follow the tract of Simon, Scherer, and Lehmann, important results at no distant date.

To arrive at positive conclusions, it becomes a matter of the utmost importance, that the different morbid products should not be confounded with each other. This has been done even by Scherer. Thus, in his analysis of tubercle from the liver, the appearances under the microscope, prove the disease to have been cancer, and not tubercle. Hence, it is incumbent on the chemist, to give with each analysis, an account of the minute structure of the matter operated on. Unless this be done, we must anticipate confusion, rather than harmony, from the multiplication of analyses of morbid products.

now that attention is directed to these subjects, some thing positive will soon be ascertained. No doubt, there are great difficulties to be surmounted. Organic chemistry is yet in its infancy. Only lately, Reichenbach discovered sulphur in considerable quantity, as a constituent of animal bodies. Even now, the existence of protein, which promised to facilitate our knowledge of organic compounds, has become a subject of dispute. At the last meeting of the Royal Society of this city (April, 1846,) Dr. G. Wilson showed that the fluoride of calcium, which had hitherto been considered insoluble in water, was, on the contrary, soluble to a considerable extent. He detected it in recent and fossil plants and animals, in the blood, and in milk. If, then, the very basis of organic analysis is thus uncertain; if we are as yet ignorant of the chemical constitution of the animal solids and fluids in a state of health, we need not feel surprise at the little assistance pathology has hitherto received from the chemist. We anticipate, however, from the labours of those who follow the tract of Simon, Scherer, and Lehmann, important results at no distant date.

To arrive at positive conclusions, it becomes a matter of the utmost importance, that the different morbid products should not be confounded with each other. This has been done even by Scherer. Thus, in his analysis of tubercle from the liver, the appearances under the microscope, prove the disease to have been cancer, and not tubercle. Hence, it is incumbent on the chemist, to give with each analysis, an account of the minute structure of the matter operated on. Unless this be done, we must anticipate confusion, rather than harmony, from the multiplication of analyses of morbid products.