It is of more importance that you should understand the *theory* of cattle-feeding than you can, perhaps, imagine, before you have gone regularly through the question; much more important than the theory of manuring land; for in the latter case, an overdose of manure may be a waste of material for the season, but the overplus will remain in the land ready for the next crop; but an overdose of food will often lead to the detriment, sometimes even to the loss, of the animal under treatment.

I must repeat myself a little here. As it is nearly four months since we talked together, it would be as well to remind you that the constituents of animals, that is the materials of which their frames are composed, are exactly the same as the materials of which plants are composed, so far as the essentials of life and growth are concerned. Teeth and bones, hair, wool and feathers, contain *fluorine* and *silicon* in addition: the *combustible* elements are:

Carbon
Oxygen
Hydrogen
Nitrogen
Sulphur (partly combustible)

The incombustible:

Potassium
Magnesium
Calcium
Iron
Phosphorus
Sulphur (partly incombustible)

Besides these, sodium, silicon, and chlorine, with some other elements in minute quantities, such as manganese, are often present, but do not appear, according to the most recent researches, to be absolutely necessary to plant life. Of course they discharge some useful functions, or nature would not have put them there.

Again, we saw (v. p. 52, vol. 4) that the three proximate principles, albumen, casein, and fibrin, were common to both animals and plants, and that it was clear that they both spring from a common origin; but, whereas from such simple substances as carbonic acid, nitric acid, water, and salts, a plant is able to manufacture a vast number of different compounds by a simple consumption of force external to itself, which force is *sunlight*, an animal has no such power: it wants its materials ready made—it finds little assistance from any external force; in fact, the keeping up of the natural heat of the body is effected by the combustion of the food consumed; and every stroke of work done by horse, ox, mule, or ass, is derived from the same source. Thus, while food merely provides plants with materials for building up vegetable tissues; animals must, in addition, be furnished with the means of producing heat and mechanical force.

The combustible matter of animal bodies is composed chiefly of nitrogenous substances and of fat. These nitrogenous bodies used to be called *protein* compounds, from their appearing in so many different forms, but they are now generally classed as *albuminoids; gelatinoids;* and *keratin*, or the horny matter. These are nearly allied to each other, but they serve for varying purposes: albuminoids make up the mass of animal muscle and nerve, with the greater part of the solid matter of blood; skin and sinew, cartilage and bone, are largely indebted to the gelatinoids; while keratin is demanded by horn, hair, wool, and feathers: they are all nitrogenous, remember, and are the most valuable and important parts of the animal economy.

Bones constitute by far the largest part of the incombustible matter of animals. If a really fat beast were burned, from 75 to 85 0/0 of the whole ash would be found to be derived from the bones. Bone ash, as we have seen (v. p. 167, vol. 3,) consists mainly of phosphoric acid and lime; but in the ash of the muscles potash and phosphoric acid form the chief ingredient, as they do in the yolk of wool: and a useful thing it is in that position, enabling us, as it does to wash our sheeps' fleeces clean from all impurities without any extraneous aid of soap.

Amongst other things for which we are indebted to Sir John Lawes, the following table of the composition of the whole bodies of animals will not be found the least valuable:

Percentage composition of whole bodies of animals; stomachs &c. removed.

	Fat calf	Half fat ox	Fat ox	Store Sheep	Fat Sheep	Extra fat Sheep	Store pig	Fat pig
Water	65 1	56 0	48 4	61 0	46 1	37 1	58 1	43 0
Nitroge. matter	15 7	18 1	15 4	15 8	13 0	11 5	14 5	11 4
Fat	15 3	20 8	32 0	19 9	37 9	48 3	24 6	43 9
Ash	3 9	5 1	4 2	3 3	3 0	3 1	2 8	1 7

The fat pig was a *porker*, not a bacon-hog, or he would have shown a much higher percentage of fat. The table is very simple, but worthy of great attention. The first thing in it that strikes our eye is the immense amount of water contained in the animal body. In a fat calf, weighing one hundred pounds of meat, skin, and bone, there are actually 6½ imperial gallons of water; and the whole solid substance only weighs 35 lbs, and might be packed into a very small compass indeed! Again, while the carcase of the fat ox shows 15.7 0/0 of nitrogenous matters, the fat sheep gives only 11.5 0/0 and the fat pig about the same; no wonder that when, in bygone times, I was preparing for a boat-race at Cambridge, my trainer forbid all animal food but underdone beef! speaking with supreme contempt of "them sheep-nibblers," as he termed the eaters of mutton chops. (1)

We see that the half, fat ox contains a greater percentage of nitrogenous matters than the fat ox—18.1 to 15.4—while the calf gives as much as the fat ox, or nearly so. From this we gather, that the *percentage* of nitrogenous matters increases with growth, but decreases again in the process of fattening.

Another Rothamsted table gives ash constituents and nitrogen in the fasted live weight of animals slaughtered there. Each animal is supposed for convenience to weigh 1000 lbs. We have, also, nitrogen and ash constituents of wool and milk.

Ash constituents and nitrogen in 1000 lbs of various animals and their products:

	Nitrogen	Phosphoric acid	Potash	Lime	Magnesia
Fat Ox	23 18	16 52	1 84	19 20	0 63
Fat Sheep	19 60	11 29	1 59	12 80	0 50
Fat Pig	17 57	6 92	1 48	6 67	0 35
Wool, unwashed	73 00	1 00	40 00	1 00	0 70
Milk	6 40	2 00	1 70	1 60	0 20

Observe, how very large the proportion of nitrogen in the ox is compared with the other animals of the farm: again, look at the immense amount of potash in the wool of the sheep, 40 lb. in 1000 lb. of wool! At this rate, a heavy fleece must often contain more potash than the whole carcase of the shorn sheep.

Fast a fat ox thoroughly, and his dead weight will generally be to his live weight as 60: 100—that is the carcase of a

(1) The Greek trainers fed their athletes on pork! More, I fancy, to fatten them to prevent their feeling the blows in the "pancration," than to harden them for long contests. I do not find that the pugilist aimed at defending himself: he had to "bide the buffet," v. the fight between Friar Tuck and king Richard—Ivanhoe, near the end. In the days of the *ring*, the fight often lasted two or three hours and demanded great powers of endurance.