PIONEERS OF OSTEOGENY

JOHN HUNTER : 1728-1793

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Hunter made observations on the growth of bone when he first began his lectures in 1772 but his experiments to show the method of growth were probably made long before this date. He was endeavouring to prove two hypotheses: 1) that growth takes place by the addition of new bone on the surface; and 2) that the rate of growth is not uniform in all parts of the bone. Two different methods were used. Original specimens of each type of experiment are still preserved in the Museum of the Royal College of Surgeons of England and are here illustrated. In both methods Hunter had been anticipated by Henri Louis Duhamel du Monceau (1700-82).

FIG. 1

Photograph of one of John Hunter's specimens, with the original note, illustrating his experiments in the investigation of bone growth by the insertion of lead shot into drill-holes.

Though Hunter left no consecutive description of his many experiments on bone growth, extracts from his writings give a clear indication of his methods and results: "Bones do not grow by having new particles put into the interstices of previously formed parts, so as to remove these to a greater distance from each other, by which means they should grow larger—as, for instance, if I put a sponge into water, the water getting into all the interstices makes

it larger—but they grow by the addition of new bone on the external surface. I took a pig of a very large breed when young, bored two holes in the tibia, and put a shot into each, measuring on a card the distance of each from the other. I allowed this pig to grow up to its full size, then killed it and took out the bone, and I found the two holes exactly the same distance from one another as at first. Now if the bone had grown in all its parts, these two shot would have been removed to a distance from each other proportionate to the growth of the bone."

A similar experiment was made on the right tarso-metatarsus of the domestic fowl and Fig. 1 is a photograph of the actual specimen. It also shows the original note of the experiment which is preserved in the jar. Fig. 2 is a photograph of another of Hunter's specimens in which he used a different method to demonstrate the same thesis—that bone does not grow at the same rate throughout. This preparation is the left tarso-metatarsus of the domestic

FIG. 2

Photograph of another Hunter specimen, preserved in the Royal College of Surgeons of England, in which he determined the method of bone growth by measuring the distance between points of cauterisation.

fowl and here he was able to prove that increase of bone distal to the points of cauterisation is more than double that of the space included between them. Here again the original note on the experiment is preserved in the jar.

The second group of experiments consisted in feeding animals with madder, which has the property of staining more vividly with a red colour that part of the bone which is added while the animal is being fed with food mixed with madder. Hunter's best description of these experiments is to be found in that section of his work which deals with growth of the teeth: "Take, for example, any young animal, as a pig, and feed it with madder for three or four weeks; then kill the animal, and upon examination you will find the following

appearances: first if this animal had some parts of its teeth formed before the feeding with madder, those parts will be known by their remaining of the natural colour; but such parts of the teeth as were formed while the animal was taking the madder will be found to be of a red colour. This shows that it is only those parts that were formed while the animal was taking the madder that are dyed; for what were already formed will not be found in the least tinged. This is different in all other bones, for we know that any part of a bone which is already formed is capable of being dyed with madder, though not so fast as the part that is forming: therefore, as we know that all other bones when formed are vascular, and are thence susceptible of the dye, we may readily suppose that the teeth are not vascular, because they are not susceptible of it after once being formed. But we shall carry this still further: if you feed a pig with madder for some time, and then leave off for a considerable time before you kill the animal, you will find the above appearances still subsisting, with this addition, that all the parts of the teeth which were formed after leaving off feeding with the madder will be white. Here then in some teeth we shall have white, then red, and then white again; and so we shall have the red and the white colour alternately through the whole tooth. This experiment shows that the tooth, once tinged, does not lose its colour: now as all other bones that have been tinged lose their colour in time, when the animal leaves off feeding with madder (though very slowly), and as that dye must be taken into the constitution by the absorbents, it would seem that the teeth are without absorbents as well as other vessels. This shows that the growth of the teeth is very different from that of other bones. Bones begin at a point, and shoot out at their surface, and the part that seems already formed is not in reality so, for it is forming every day by having new matter thrown into it, till the whole substance is complete and even then it is constantly changing its matter." Fig. 3 illustrates these madder experiments and is a photograph of the lithograph made from the original drawing prepared for Hunter by his assistant, William Bell. The original drawing is preserved in the library of the Royal College of Surgeons.

Mention of "absorbents" in the above extract brings us to Hunter's original conclusions concerning bone and bone growth: "Since we know that bones do not grow by fresh matter being put into all parts, so as to push the old matter to a greater distance but by new matter laid upon the external surface, let us see whether it is possible for bone to grow and retain its form without being taken down. Let Fig. 3, Plate XX, represent the head of the thigh bone of a foetus. Now if the increase was accomplished by superimposed layers, one over the other, as in Fig. 4, the head of the bone would necessarily become of an enormous size and in time would come down so as to occupy the middle of the bone while the cavity in the centre would not be enlarged. Absorption, therefore, must necessarily go on to keep the bone of its proper shape. Hence I call this the modelling process, for without this combined

FIG. 3

Photograph of William Bell's lithograph illustrating John Hunter's madder experiments.

action of absorption and deposition the animal could not grow as it now does." The original figures to which Hunter alludes are reproduced in Fig. 4.

In addition to his experiments conducted to show the actual way in which increments were added to growing bone, Hunter (in Owen's "Essays and Observations") made this

FIG. 4

Plate XX of John Hunter's works illustrating the principle of the "modelling process."

shrewd, and doubtless original, observation on the tissue basis from which bone could be developed: "Bone is not the original skeleton in any animal, but only of the adult; for in the first formation of any animal, which afterwards is to have bone, the skeleton is either membrane or cartilage, which is changed *for* bone, but not *into* bone."

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