

II. *Observations upon the Bones and the Periosteum, in a Letter to the Royal Society, from Mr. Leeuwenhoek, F. R. S.*

Delft, Nov. 20. 1720.

SOME Years ago, I communicated to the *Royal Society*, my Observations upon the Bones; what those Observations were, I do not now remember, nor have I endeavour'd to recollect them, lest I might be influenced by them in my later Enquiries, which I here present you with.

In my last Letter I acquainted you, that I had several times endeavour'd to discover, after what manner the *Periosteum* was united to those Vessels, that compose the Bone, but that I had not been able to observe it to my satisfaction. Since which time I have frequently employ'd myself in making Observations upon the Bones, and have found that the superficial part of them consisted of an inconceivable number of small Vessels, and some few of a larger size, which last, when they came to the surface of the Bone, appear'd to me to be clothed with either a Membrane, or a bony Substance, that was perfectly transparent.

I once happen'd to discover in a small portion of a Shinbone, four or five Vessels of such a size, that a single filament of Silk might have been drawn thro' their Aperture. One of these appear'd to me to consist of two openings, each of which seem'd to be provided

vided with a Valve, which was disposed in such a manner, as to let out what was contain'd in the Vessel, but to suffer nothing to go in. In all my Observations upon the surface of the Bones, I never, but this one time, discover'd so many of these Vessels in so small a compass.

As for that Matter, which issues out from the Bone, and is carried into the *Periosteum*, I have discover'd the source of it to be the spongy or cellular Substance on the inside of the Bone, which is the repository for the Marrow.

This spongy Substance consists of long Particles closely united and link'd together, which Particles are compos'd of an infinite number of small Vessels, some running lengthwise, and others taking their course towards the sides of the bony Particles.

These bony Particles, notwithstanding their great number of Apertures, are yet exceeding hard, and lie some of them parallel, and others perpendicular to the length of the Bone.

Those Particles, that lie perpendicular to the length of the Bone, have Vessels proceeding from their ends; and from their sides, where they do not lie close together, proceed other Vessels, that compose the *Cortex*, or superficial part of the Bone. And those bony Particles that lie parallel to the length of the Bone, send out Vessels from their sides, that issue out thro' the side of the Bone: It is impossible for those, who have not seen this with their own Eyes, to conceive the prodigious number of small Vessels, of which the cortical part of the Bone consists; which in some places lies no thicker upon the spongy part of the Bone, than a thick Hair of a Man's Head, tho' in other places it has three or four times that thickness.

To the *Cortex* of the Bone, the *Perioſteum* is united, not only on the outside, but even by entering in many places into the very ſubſtance of the Bone, and is join'd to it by the Veſſels, which iſſue out from the Bone, in ſuch a manner, that ſometimes one cannot determine which is the Bone, and which belongs to the Membrane inveſting it, they both appearing in the Microſcope to conſiſt alike of exceeding ſmall Veſſels.

To make this be the better underſtood, I have given in Fig. 1. a representation of a ſmall part of the Bone, with the *Perioſteum* adhering to it, in which *ABCDEF* represents the bony part, whether taken from an Ox, or Sheep, I do not now remember. The *Perioſteum* is mark'd with the Letters *BGHIE*, the thickneſs of which is deſign'd by *BG*, or *IE*, tho' in other places of the Bone, and even at no greater diſtance than two or three Hairs breadth, it is twice or thrice as thick. We ſee here, that all the ſmall Veſſels in the *Perioſteum* are represented by ſo many Dots or Points; but in other places, where I had ſeveral times ſeen the Membrane of twice this thickneſs, the upper half of it has appear'd to be of a different make from the under part, for as much as in the upper part I could diſcover not only thoſe Veſſels, that had been cut tranſverſly, and which conſequently were represented by ſo many Points, but likewiſe a great number of other Veſſels running lengthwiſe along the Membrane, as is represented in Fig. 2. by *LOP QNM*.

I am fully perſuaded, that the part represented by *BGHIE*, Fig. 1. is not entirely membranous, but that ſome part of it is really bony. If we cut thro' the *Perioſteum* ſo deep as to divide the part of the Bone mark'd with the Letters *ABCDEF*, in the ſame Figure, we find the ſame appearance of Pores in

the bony Substance, which are no other than the transverse Sections of small Vessels; and besides these, there are other Vessels running longways in the Bone. And we find just the same in those transparent parts, that lie between the bony Particles, which are represented thicker between *B C D E*, than they appear'd to me.

It is my Opinion, that the use of these bony Particles is, to convey an Oleaginous Liquor into the *Periosteum*, and that from the *Periosteum* it is carried by the intervention of the other Membranes into all parts of the Body, when in a healthful Condition.

In another place, I saw a great number of Vessels arising from a greater depth within the Bone, which drew closer together, so as to compose small *Fasciculi*, before they entred the *Periosteum*, in which they separated one from another, and dispers'd themselves again. It is difficult to determine, whether these Vessels bring any Liquor into the Bone, or carry it out; but I rather think they serve to carry it out of the Bone.

Having placed another piece of Bone before the Microscope, with the *Periosteum* adhering to it, I could discover a great number of Vessels, that I had cut thro' lengthways, as they ran along the *Periosteum*, and others that were cut thro' transversely, and appear'd as so many Points, as is represented in Fig. 2. by *K L O P Q N A*, where the bony part is mark'd by the Letters *K L M N A*, in which, tho' no Pores, or Vessels, are here represented, yet is it full of openings. That part, which is design'd by *L O P Q N M*, we must not take to be entirely membranous, for I am of opinion, that that part of it, which lies next the Bone, and which is represented by *L M N*, is of a bony Substance.

I had.

I had another small piece of Bone lying before a Microscope, of which I caus'd a part to be represent'd by *R S W X T V*, Fig. 3. in which *R S T V* is the Bone, and *S W X T* the *Periosteum*, which in this place was no thicker than a thick Hair of a Man's Beard, but in another part of the same Bone at a small distance, it was full four times that thickness.

I placed another piece of Bone before a Microscope in such a manner, as that the Bone did not appear, but only the *Periosteum* and the Muscular Fibres, which were cut thro' transversly, and appear'd to be surrounded by the *Fibrillæ* of the *Periosteum*, as is represent'd by *T Z C D A B*, Fig. 4. where *T Z A B* is the *Periosteum*, and *Z C D A* are the fleshy Fibres cut thro' transversly. This piece of Bone was taken from one of the Ribs of a fat Ox, and I was surpris'd to find, that in this place, as I cut longways thro' the Rib, I could not discover any Particles of the Marrow, whereas in other parts the Rib abounded with them.

Notwithstanding the great number of Observations that I have made upon the Bones, and the Membrane that surrounds them, which is commonly call'd the *Periosteum*, I have never been able to satisfy myself entirely about them. I still imagin'd, that the part of the *Periosteum*, which immediately covers the Bone, and is strictly united to it, must have a degree of hardness approaching to that of the Bone, and that at a small distance from the Bone, the *Periosteum* must have a softness and flexibility like that of the carneous and adipose Membranes.

I had lying by me four pieces of Ribs of a fat Ox, which I had kept by me full two Months, and which were now grown very dry. From one of these I tore off the *Periosteum*, which I found stuck much  
harder

'harder to the Bone than I could have imagin'd, and I observ'd, that a great many Particles of this Membrane were left on cleaving to the Bone. This I did with design to make some Observations on the superficial part of the Bone, which is not near so hard as those bony Particles, that lie a little deeper. From this Bone I cut off some very thin slices, both along the Bone, and likewise transversly, one of which I placed before a Microscope, and gave it to the Painter, that for many Years has drawn all my Observations.

This Piece is represented by *ABKC*, Fig. 5. having been cut off transversly, and as thin as possible, from the Rib, with part of the *Periosteum*, as from *K* to *C*, still adhering to the Bone, and another part of it torn off from the Bone, as design'd by *BKD*, except that in some places the Bone and the Membrane are still united by Vessels torn out of their places, that run from one to the other. In this Figure *DEFC* represents the *Periosteum*, and the part design'd by *EGHIF*, is something lying upon it, which I could not tell what to make of, tho' it appear'd to me to be Membranous.

I had likewise some very thin slices shaven off from the Rib both of an Ox, and of a Calf, from which I tore off the *Periosteum* entirely, or at least as much of it, as possibly I could; after which I caused the edge of the Bone it had stuck to, to be represented by the crooked Line, *LMN*, Fig. 6.

In Fig. 7. *OPQ* represents the edge of another small slice of Bone, from which the *Periosteum* has been torn off, by which appearance it should seem, that the Union of the *Periosteum* with the Bone is so firm and strong, that, in separating it, some of the superficial Particles of the Bone are torn off with it.

I have likewise discover'd some Vessels running along within the Marrow-bone of the Shank of an Ox, that seem'd to be Blood-vessels.

Since now it appears from our Observations, which have been made with great Diligence and Care upon Bones of all kinds, that the Bones do for the most part consist of exceeding small Vessels, which Vessels arise from the inner, hollow, or spongy part of the Bone, and passing thro' the superficial or cortical Substance, enter the *Periosteum*, and are from thence continued farther into the Body, yea even into the utmost parts of the Body; we may from hence reasonably conclude, that, in a healthful Body, as there is a constant supply of an Oily Substance carried into the Bones, so this is again constantly carried out from the Bones by means of these Vessels, into all parts of the Body, even to the extremities of the Fingers. To give an evident proof of this, let any Man lay the ends of his Fingers upon a clean and bright Pewter Plate, and he shall find the Pewter appear foil'd in the place where he has touch'd it; for in reality this Soil is nothing else, but some Oleaginous Particles discharg'd from the ends of his Fingers. There is indeed something of a watery Substance mix'd with the Oily Particles, but this evaporates in a little time, and leaves the Oily Particles lying upon the Plate.

FIG. I.

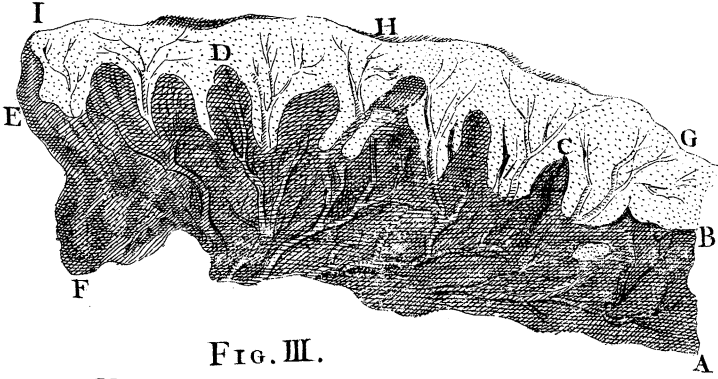


FIG. II.

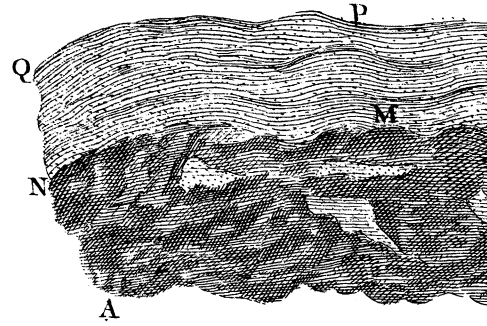


FIG. III.

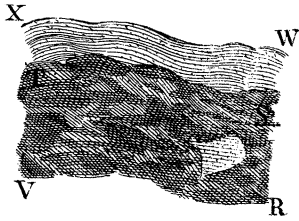


FIG. V.

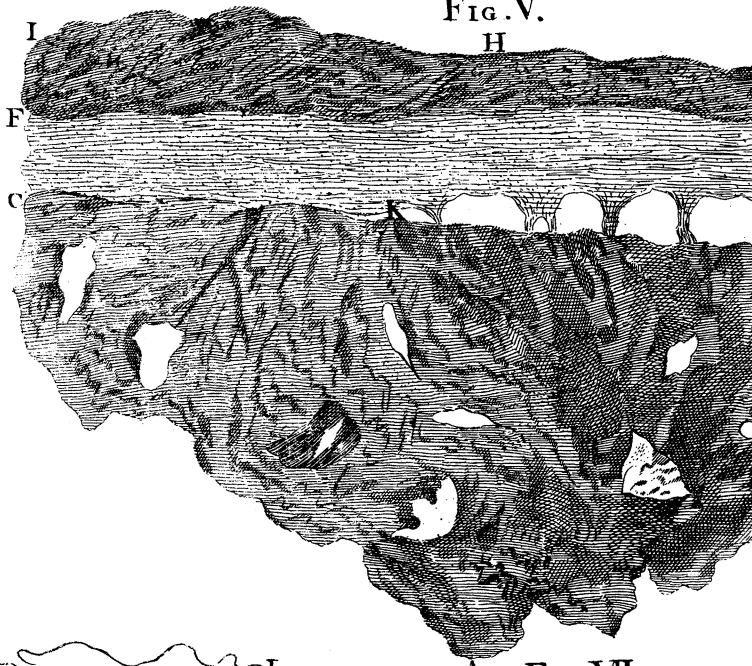


FIG. IV.

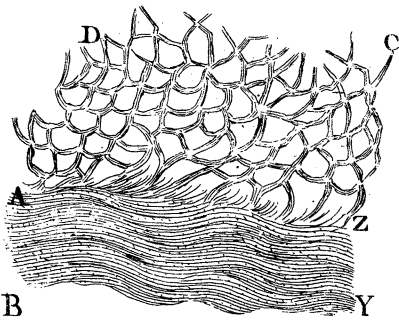


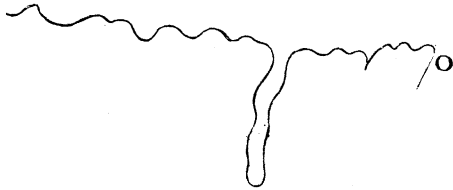
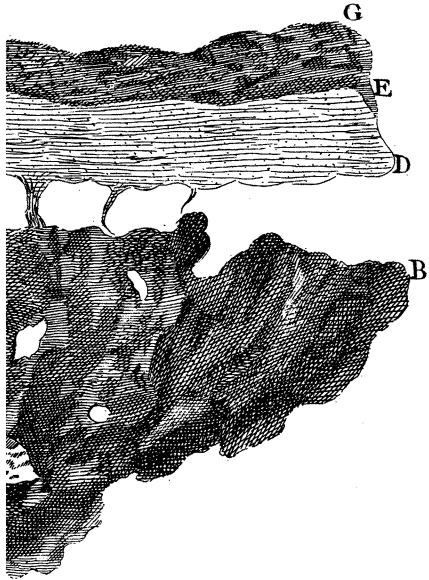
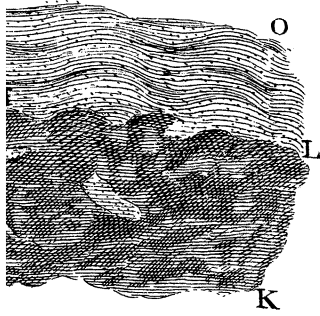
FIG. VI.



FIG. VII.







*I. Sturz, sculp.*

FIG. I.

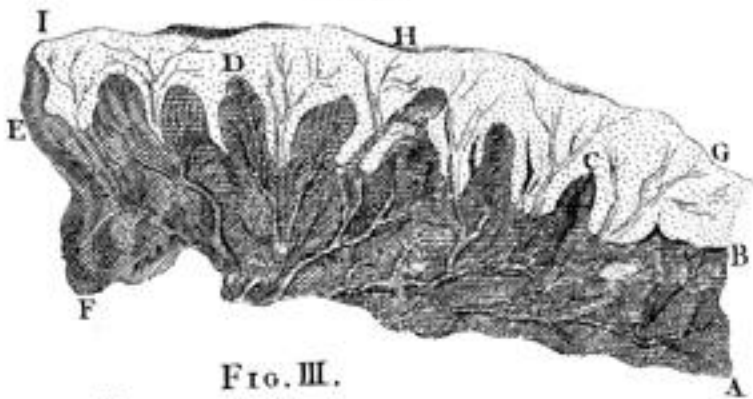


FIG. II.

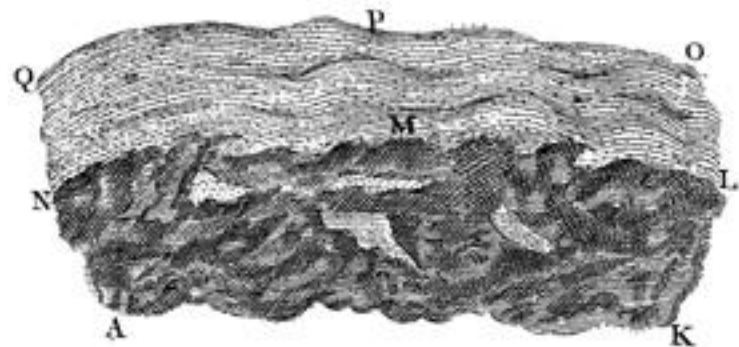


FIG. III.



FIG. V.

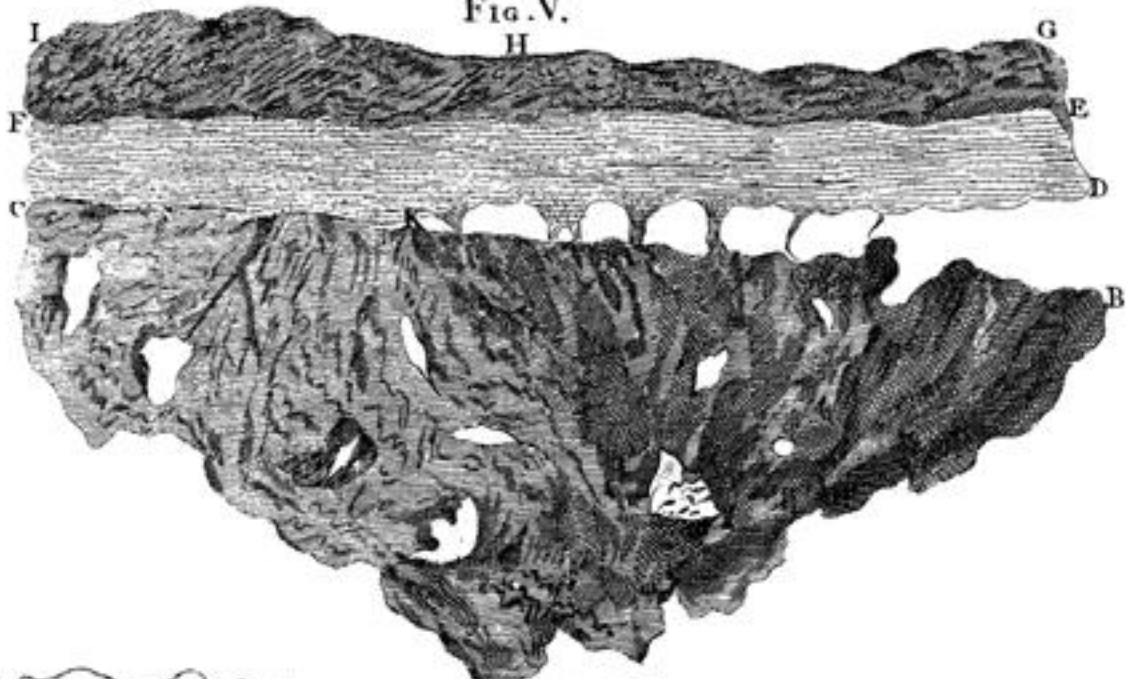


FIG. IV.

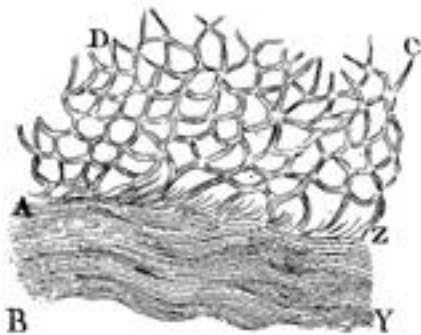


FIG. VI.

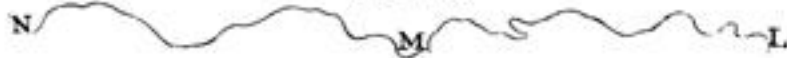


FIG. VII.

