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 cloathed 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 pro-

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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, aud 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

To the *Cortex* of the Bone, the *Perioſteum* is united, not only on the outſide, but even by entring 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 *A B C D E F* repreſents the bony part, whether taken from an Ox, or Sheep, I do not now remember. The *Perioſteum* is mark'd with the Letters *B G H I E*, the thickneſs of which is deſign'd by *B G*, or *I E*, 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 *L O P Q N M*.

I am fully perſuaded, that the part repreſented by *B G H I E*, 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 *A B C D E F*, 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' tranſverſly, 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 repreſented 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 repreſented 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 *A B K C*, 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 *B K D*, 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 *D E F C* repreſents the *Perioſteum*, and the part deſign'd by *E G H I F*, 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, *L M N*, Fig. 6.

In Fig. 7. *O P Q* 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

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 ſoil'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.

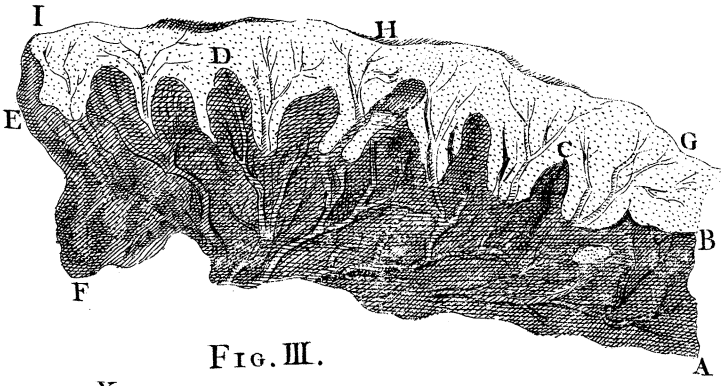


FIG. II.

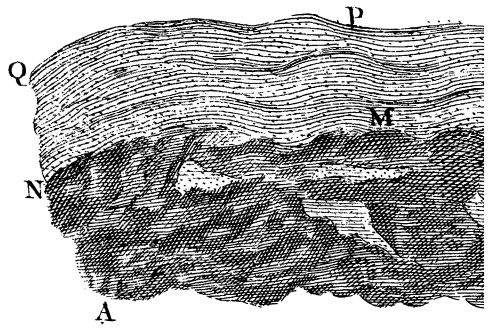
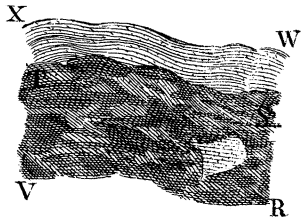


FIG. III.



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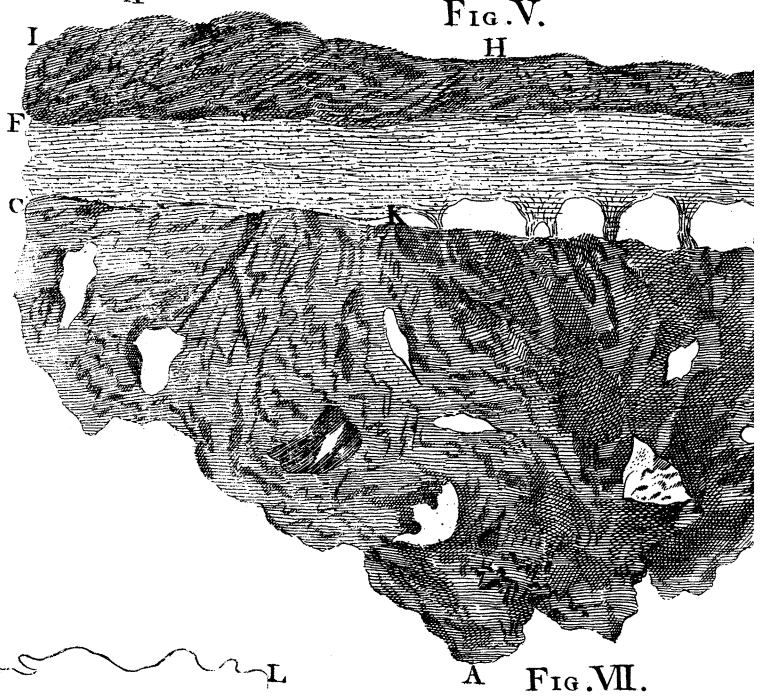


FIG. IV.

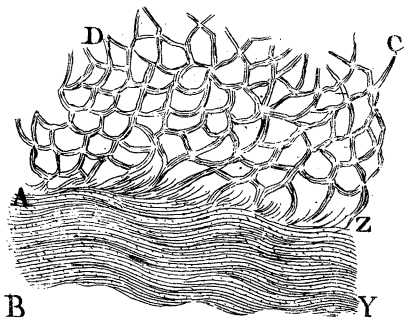
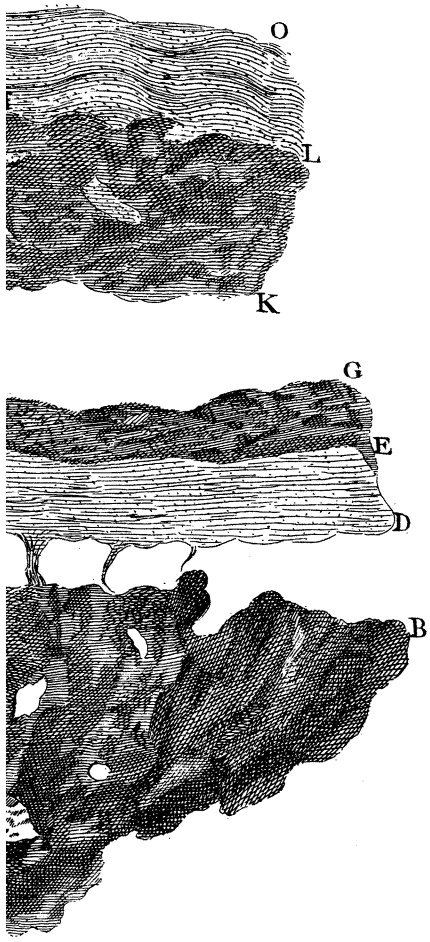
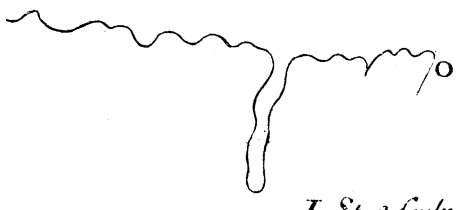


FIG. VI.

FIG. VII.





I. Sturt. sculp.

Fig. I.

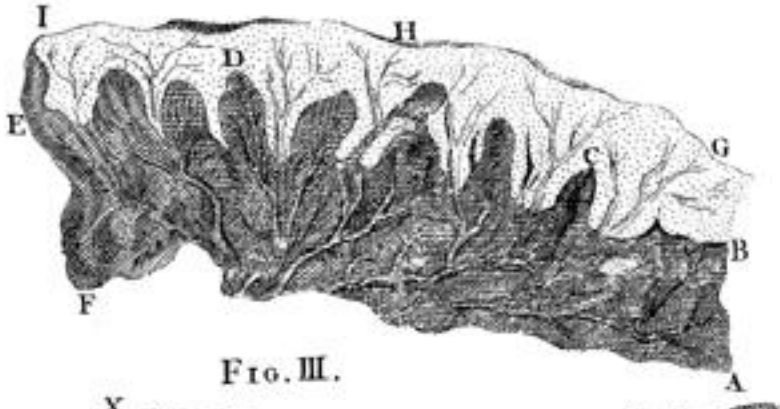


Fig. II.

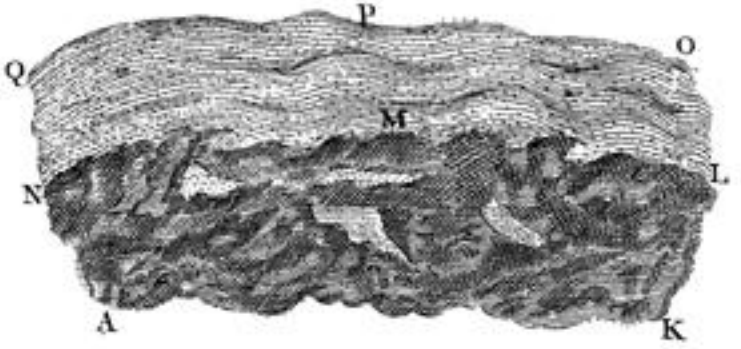


Fig. III.

Fig. V.

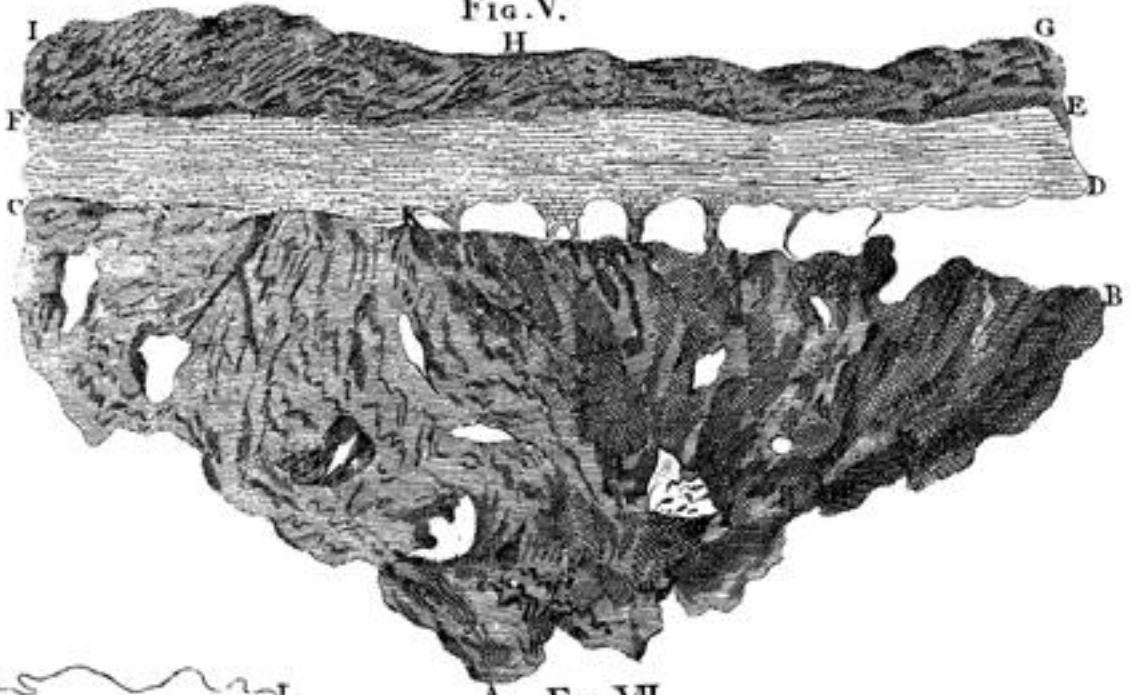


Fig. IV.

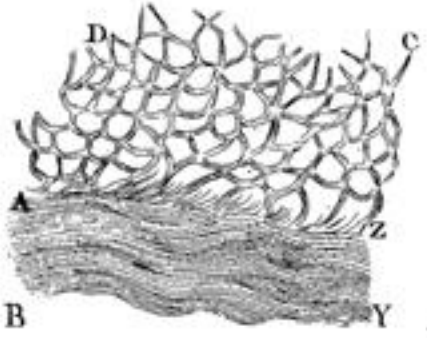


Fig. VI.

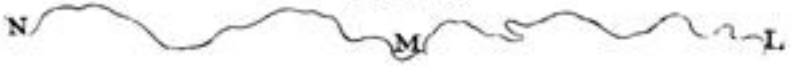


Fig. VII.

I. Stuart sculp.