

III. *A-Letter from Mr Antony van Leeuwenhoek, F. R. S. concerning the flesh of Whales, Crystalline humour of the Eye of Whales, Fish, and other Creatures, and of the use of the Eye-lids.*

Delft in Holland, July 22. 1704.

I Take the liberty to communicate these my Observations, which I made last year when our Ships return'd from the Whale-Fishery.

I have often concluded, that the Globules of Blood (which are the cause of its Redness) are of the same magnitude both in great and small Animals, and consequently that the Particles of Blood in a Whale are no larger than in another Fish no bigger than a Pin.

Not being able to get at any Whale's Blood, I was forc'd to acquiesce in bare speculations.

From the Particles of Blood my thoughts wander'd to those of the Flesh of a Whale, whereupon I desir'd some that were concern'd in the Fishing to bring me a piece of Whale's Flesh, imagining that the Flesh-Particles of the said Fish were no bigger than those of a Horse or Cow, and that the bulk or largeness of a Whale consisted only in the multitude of number of Particles.

The piece of Whales Flesh which was brought me had no very good smell, by reason of its being almost putrify'd; I cut it thro' cross-ways, in order to separate the Flesh-Particles according to their length; and I must own, that according to the best of my judgment, I could discover no difference between the said Particles (in their sight) and those of a large Ox.

The reason why I compare a Whale with a great Ox, is, because I imagin that the Fibres in a great Ox are
K k k k k k k k k k
not

not more than those of a small one; nay, even in a Calf, I don't think that the Fibres are fewer in number, but only that they encrease in bigness.

A certain Labourer presented me with the Christaline Humour of a Whale's Eye, which he call'd the Eye of that Fish, and told me, that one of his Neighbours lately return'd from the Whale-fishing, had brought it home with him.

After which, the *Heer Frederic Wolfert van Overschie*, by the interest he had in one of the Commanders of a *Green-land* Ship lately return'd from the said Fishing, procur'd me two of the *Humor Cristalinus* of the same Fish, one was of a great, and the other of a small Whale, supposing that I should be glad to make some remarks on the said Humors.

Of these two Cristaline Humors I dissected the smallest, and kept the largest entire.

Tab. I. Fig. I. A B. Represents the bigness of the said Cristaline Humour when it came into my hands, tho I believe it was something larger when it was taken out of the Whales Eye; for I have observ'd, that when I have taken the Cristaline Humor out of the Cod's Eye, and laid it never so gently down, by reason of its softness, some of its substance fell from it, the which having taken and view'd with my Glasses, I could still discover in it the Fibrous Matter of which it consisted; how much more then must such a Humor of the Whale's Eye diminish, by being preserved in Saw-dust, in order to keep it stiff and hard.

The reason why some of the Sea-faring People take such pains to bring home with 'em the Cristaline Humor of a Whale's Eye is, to show it as a Wonder that so Great an Animal should have so small an Eye; for they mistake that Humor for the whole Eye.

In examining the said Cristaline Humor it appear'd to me, that the Fibrous Matter or Particles whereof it is
com-

composed, lay so very thin upon one another, making thereby such exceeding fine Scales, that lay so prodigiously thick upon one another that it was amazing to behold ; and this Fibrous Substance is thinner of Particles, than that of a Peach not a year old.

The reason why the Fibrous matter of the Cristaline Humour of a small Peach appears Thicker than that in a Whale, is, that we see the former on one side, where the Threads or Fibres are thickest, but if we view them where the Fibrous Particles meet together they are exceeding fine or slender ; whereas, on the contrary, the Fibrous Matter of the Whale not meeting together, but running by, by Crossing itself often, is of the same thickness throughout.

In my Letter of the 14th of *April*, 1684. to the Honorable Society, I imparted my Discoveries about the Cristaline Humor of an Ox, Fish, &c. and particularly I communicated the Course of the Fibrous Matter in the said Humor ; and I have discover'd that the Cristallin Humor in a Whale is of a quite different Texture or Circumvolution from the Fibrous Matter in many Creatures ; for whereas the said Humor in others consists of three particular conjoyn'd Branches, all arising out of one Point, the same Humor in the Eye of a Whale is composed of five Circumvolutions, all which unite together in one Point, and make one Scale : But I must here caution you that I only speak of the half of that Orb of the Cristaline Humor which fell immediately under my observation.

Now to describe the Smallness, as well as the Fibrous Contexture of which such a Scale consists, and whereof many lying upon one another compose the Cristaline Humour, I caus'd one of 'em to be design'd.

Fig. 2. CDEF shews a small Particle of the Cristaline Humor of a Whale's Eye, taken off from the Globu-

lar Part ; the Real Bigness of which, as it appeared to the naked Eye, is represented in Fig. 3. by G H.

At first I did not believe that I should have attain'd my end, which was so to Discover the Texture of the Fibres, as to be able to expose the exact Circumvolution to my own view, by reason that the Scaly Particles were dry'd together so hard that they were as clear as Glass ; but when I had dissected the Second Cristalin Humor, after the manner as you may see in Fig. 3. G H. I could perceive it very easily.

The above-mention'd little Particle Fig. 2. C D E F appear'd no bigger to the naked eye than Fig. 4. I K ; in which, by the help of my Microscope, I could discover the exceeding fine Threads, which I call the Fibrous Matter, with a part of the Circumvolution which compose a Fifth part or Division of the Hemisphere of the said Cristallin Humor.

May we not be amazed with the sight of such a Contexture, of which the Painter said it was impossible for him to Trace the exceeding Fine and Regular Fibres with the Red-lead Pencil, but hoped to be a little more exact when he should come to describe the same with his Graving-Iron on a Copper Plate.

These Scaly Particles don't lye thicker on each other than the Threads or Fibrous Matter are represented in the last mention'd Figure ; let us but imagine then how closely these Particles, lying upon, and near each other, must be united ; for otherwise it would be impossible for the Humor *Cristalinus* to have such a Transparency, as the nature of that Body requires.

Now, in order to have a clearer Idea of the Course of the Fibrous Matter in the Cristaline Humor of a Whale's Eye, which Fibres, as I have said before, lye in so many folds upon each other, I took a common Ball (for I could not make the Painter comprehend it any other way) and divided it into such parts as were ana-
logous

logous, or corresponded with the Divisions of the Fibrous Matter in the Crystallin Humor, and then wound it about with a single small Thread, which was to represent the Fibrous Matter that compos'd a small Scale of the said Humor.

Fig. 5. A B C D E F G H I K. Represents a Globe or Orb of the Crystalline Humor of a Whale, whereof L is the Center or Axis, and lies next to the view, where the Fibrous Particles arise out of the shortest Circumvolution of the opposit part of the Globe, and the Course of which is in some measure described by the Letters L A. L C. L E. L G. and L I.

As for the Fibrous Substance which here does first Circumvolve from the Middle point or Center, *viz.* Q B. P D. O F. N H and M K. they describe the same Circumvolution in the opposite part of the Sphere or Globe, which is here represented by L.

Then I caus'd the Painter to design the said Ball, that was wound about with a Thread on one side, that you may the better conceive the Circumvolution of the Fibrous Matter.

Fig. 6. R S T U represents the said Ball so well wound up in the single Thread, that there appear'd only the two ends of the said Thread, and the Ball was so well cover'd that hardly any of the Leather appear'd.

The Center or Axis, which in Fig. 5. is describ'd by L, where the Fibrous Matter, proceeding five several ways, does Circumvolve, as A L C. C L E. E L G. and G L I, we must suppose to be represented in this Figure by R and T.

In Figure 5. we have describ'd five other, but shorter Circumvolutions of the Fibrous Substance, as is before said, by the Letters M N O P Q; but when we had caus'd Fig. 6. to be design'd, there appear'd but three of the last mention'd Circumvolutions, as in the Letters W X Y.

And

And here again the unconceivable Order and the Wisdom of the Great Creator of all things is very obvious; for what Man is there in the World that could wind about a Globe or Ball with a single Thread of equal size throughout, and not cross it self in any point; and yet such is the Contexture of the Filaments or Fibrous matter, of which the Scales of the Cristaline Humour of a Whale are compos'd.

When I talkt with the late *Heer Christian Huygens* of *Zubichem*, about the Cristaline Humours in the Eyes of Fishes, to wit, about the Spherical Figure thereof, his answer was; What shall we say? the Eyes of the Fishes are of a wonderful form.

Since which, having carefully observ'd the Eyes of several Fishes, and particularly the *Tunica Cornea* thereof, I found that the said *Tunic*, or rather the Pupil or Apple of the Eye, was very flat, like those in Human Creatures and other Animals; from whence I concluded, that tho the Cristaline Humour in Fishes was Spherical, yet the same was made good by the Flatness of the Apple of the Eye in the same Fishes; from whence one might probably conclude, that the Eyes of Fishes are of the same contexture with other Land-creatures, and consequently the effects in both are the same. For if you observe the Sphericalness of the Apple of the Eye in Men, it will be found to be a large Eye, where the *Tunica Cornea* makes a Circle, whose Axis is an inch long.

When I had taken the Eye out of the Head of a living Cod-fish, and put the *Tunica Cornea* in several Copper Globes, or Internal Circles, it appeared to me that the protuberant roundness of the said *Tunic* was equal to the Segment of a Circle, whose Diameter was of two Inches. The said Eye was a little prominent out of the Head, like those of other Creatures, and tho the *Tunics* or Apples make a larger Circle, yet are they not bigger, and the Axis of the Cristaline Humour was a little longer than half an Inch. Now

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Now if the Cristaline Humour (which I have sometimes call'd the *Crist. Muscle*) in our Eyes, and in many other Creatures, consists of a flattish roundness, but is not perfectly Spherical, and if the Diameter of the Circle made by the Tunick of the said Eyes be an inch long, the Cristaline Humour in Fishes being Spherical, and their Tunick describing a Circle, whose Diameter is two inches, all these Eyes, as I have said before, may have the same effect.

After this I took a Whiting, which weigh'd about 9 Ounces, and examin'd the Eye thereof, which describ'd a Circle of 1 and $\frac{1}{2}$ Inch in Diameter, and the Diameter of its Cristaline Humour was very near $\frac{1}{3}$ of an Inch.

When I dissected the Cristaline Humour of a small Fish, and found the inmost part thereof no bigger than a large corn of Sand, I observ'd that the Fibrous particles, of which those exceeding small Scales were compos'd, did consist of as many parts as the uppermost Scales of the same Humour.

I did formerly resolve to make a stricter enquiry into the Eyes of Fishes, but met with so many obstacles, that I cou'd not go through with my observations, which made me delay them till now.

Now I am speaking of Eyes, I can't forbear adding, that a certain Gentleman askt me some time since, why Nature has given us Eye-lids, seeing that Fishes have none, and that his Surgeon could not tell him the reason; I answer'd, that it was absolutely necessary for us, and all Land-animals to have Eye-lids; for if it were not so, and that the Apple of our Eyes were not moistned many times in the space of an-hour, and all the foulness that might fall thereon, washt away, our Sight or the *Tunica Cornea* would be so clogg'd with filth, that we should not be able to use our Eyes; besides, the said *Tunic* would otherwise be parcht up or shrunk with heat, and consequently we should become Blind; where-

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as on the contrary, Fishes living always in Water want no Eye-lids, because the same Water keeps their Eyes ever moist and clean; with which answer the Gentleman was satisfy'd. But I have since found that I was out in my assertion, for Flounders, Plaife, Soles, and I believe all flat Fishes can cover their Eyes; and if they had not, I fancy they would lose their Sight, because the said sort of Fish are not so nimble as others in Swimming being only able to move their Tails, the chief Instruments of Speed, upwards and downwards; wherefore these Fishes in a Storm don't betake themselves to the bottom of the Sea, as I am inform'd, but dig themselves holes in the Sand, which secures them from being cast upon the Beach or Strand: Now if they had not Eye-lids, the sharp points of Sand, whilst they are making their Nest, would wound the Tunicks of their Eyes, whereby the Transparency thereof would be destroy'd, and the Fishes become blind; which is a farther proof how perfect every Creature is in its own Species. I conclude, &c.

IV. *A Letter from Mr Antony van Leeuwenhoek, concerning the Tubes or Canals that convey the yellow Sap in the Herb called Chelidonium majus, or Celandine, &c.*

Delft in Holland, September 16, 1704.

THe Heer Peter Hotton, Professor in Physick and Botany at *Leyden*, and Fellow of the Royal Society, made me a Visit lately, and discoursing of several things, he desir'd me, that I would examin the *Chelidonium majus*, to wit, whether the Canals or Tubes that bring up the yellow Sap were distinguisht or separated from other Tubes;

Tab: 1.

fig: 4.
K & I

fig: 2.

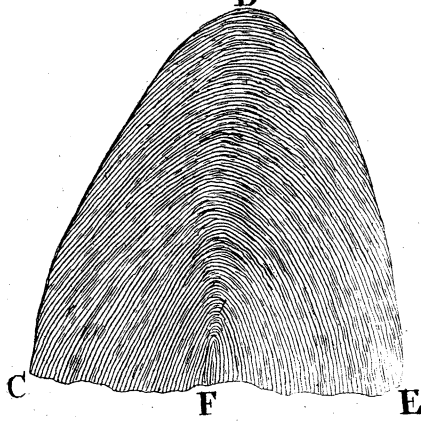


fig: 3.
H & G

fig: 1.



fig: 6.

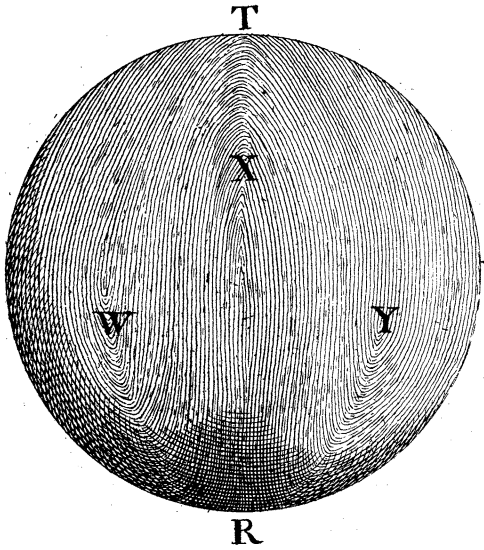


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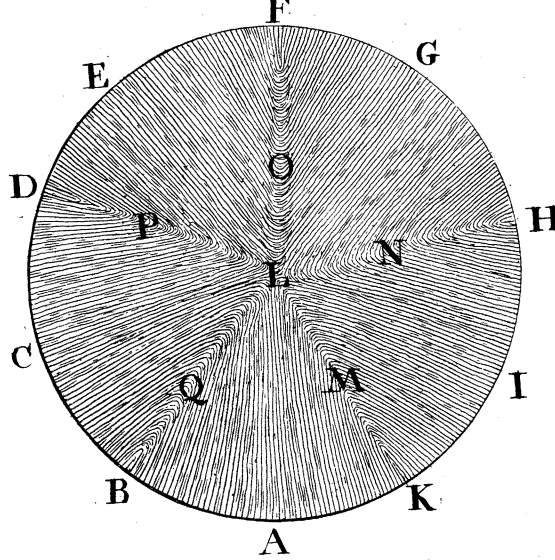


fig: 10.



Tab: 3.

fig: 4.



fig: 3.



fig: 2.



fig: 1.



fig: 8.



fig: 7.



fig: 6.



fig: 5.



fig: 12.



fig: 10.



fig: 9.



fig: 11.



fig: 7. A

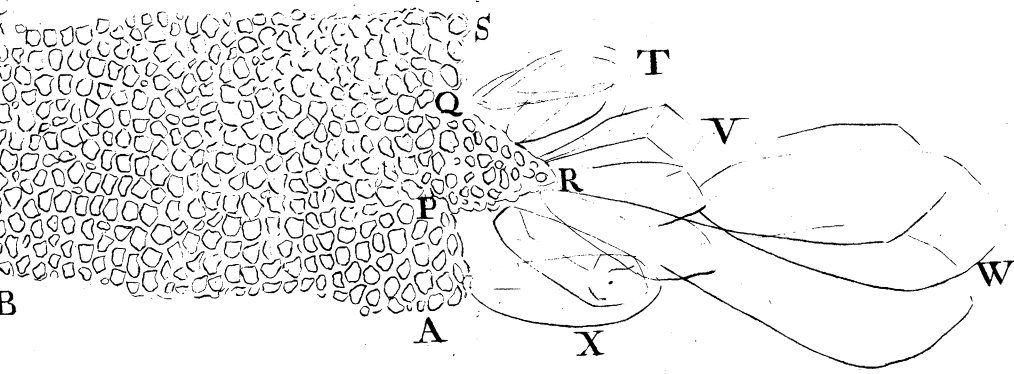


fig: 10.



fig: 9.

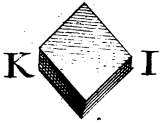


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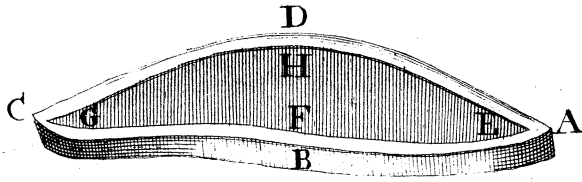


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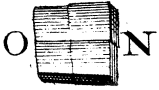


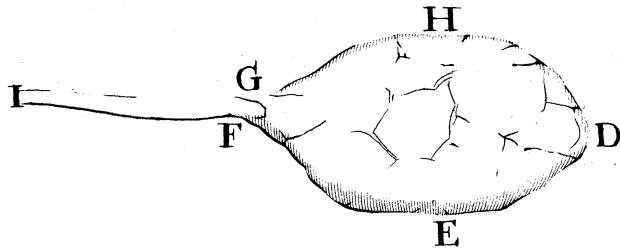
fig: 12.



fig: 11.



fig: 7. B



L
K
C
F

fig:3.

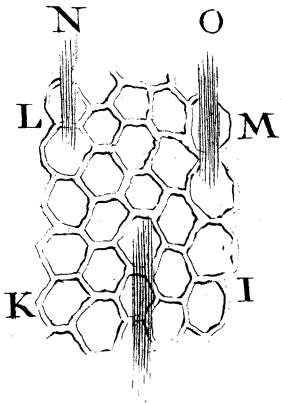


fig:2.

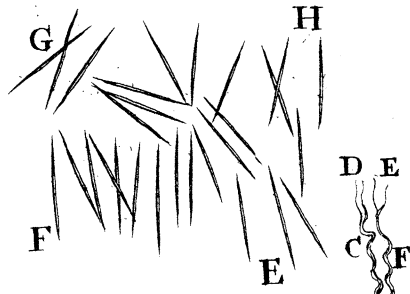


fig:1.

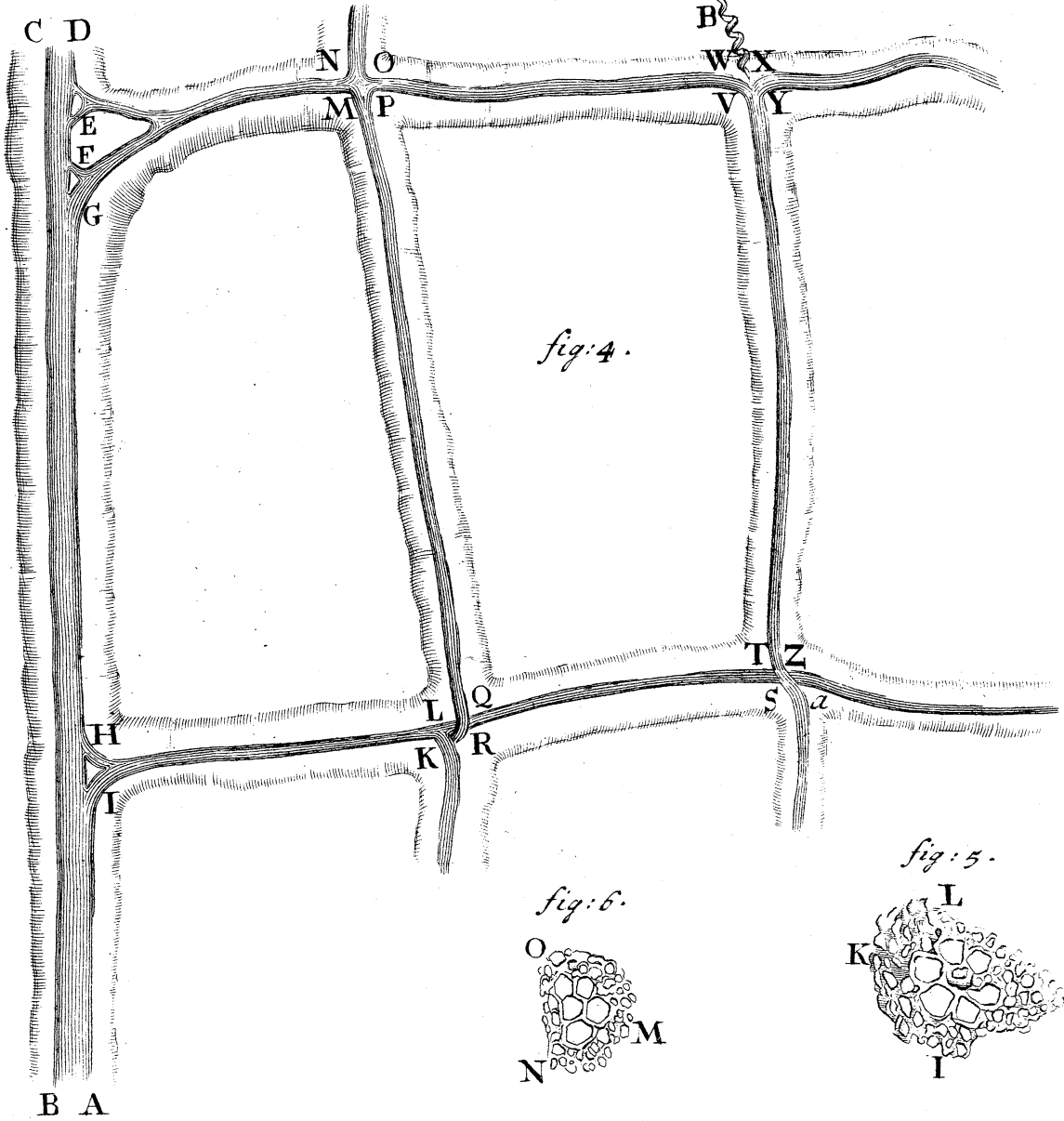
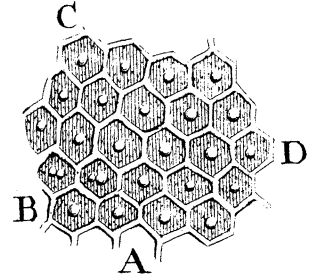


fig:4.

fig:6.

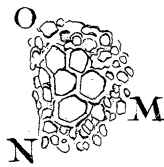
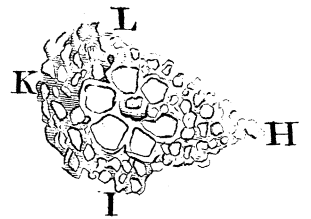
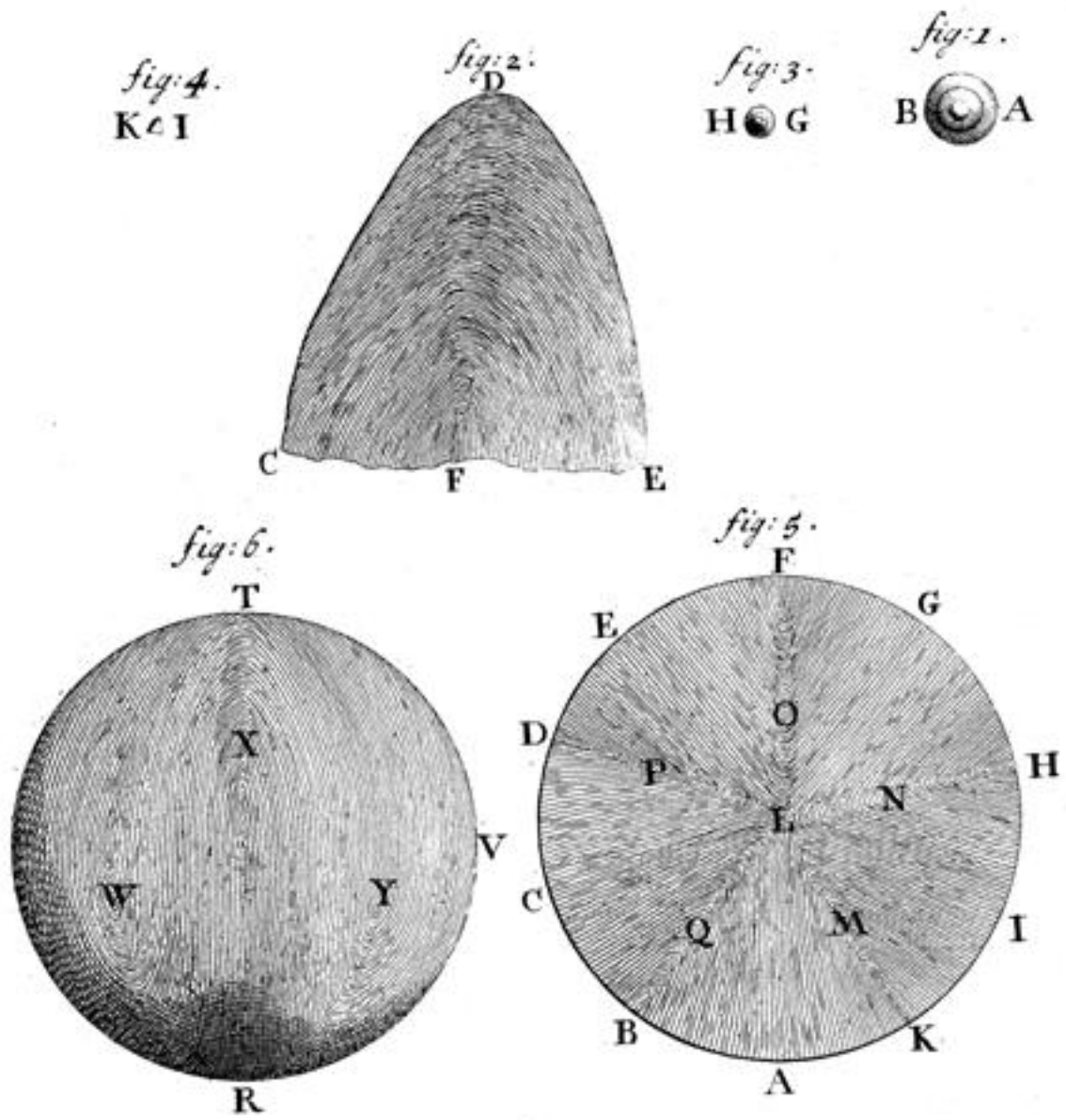


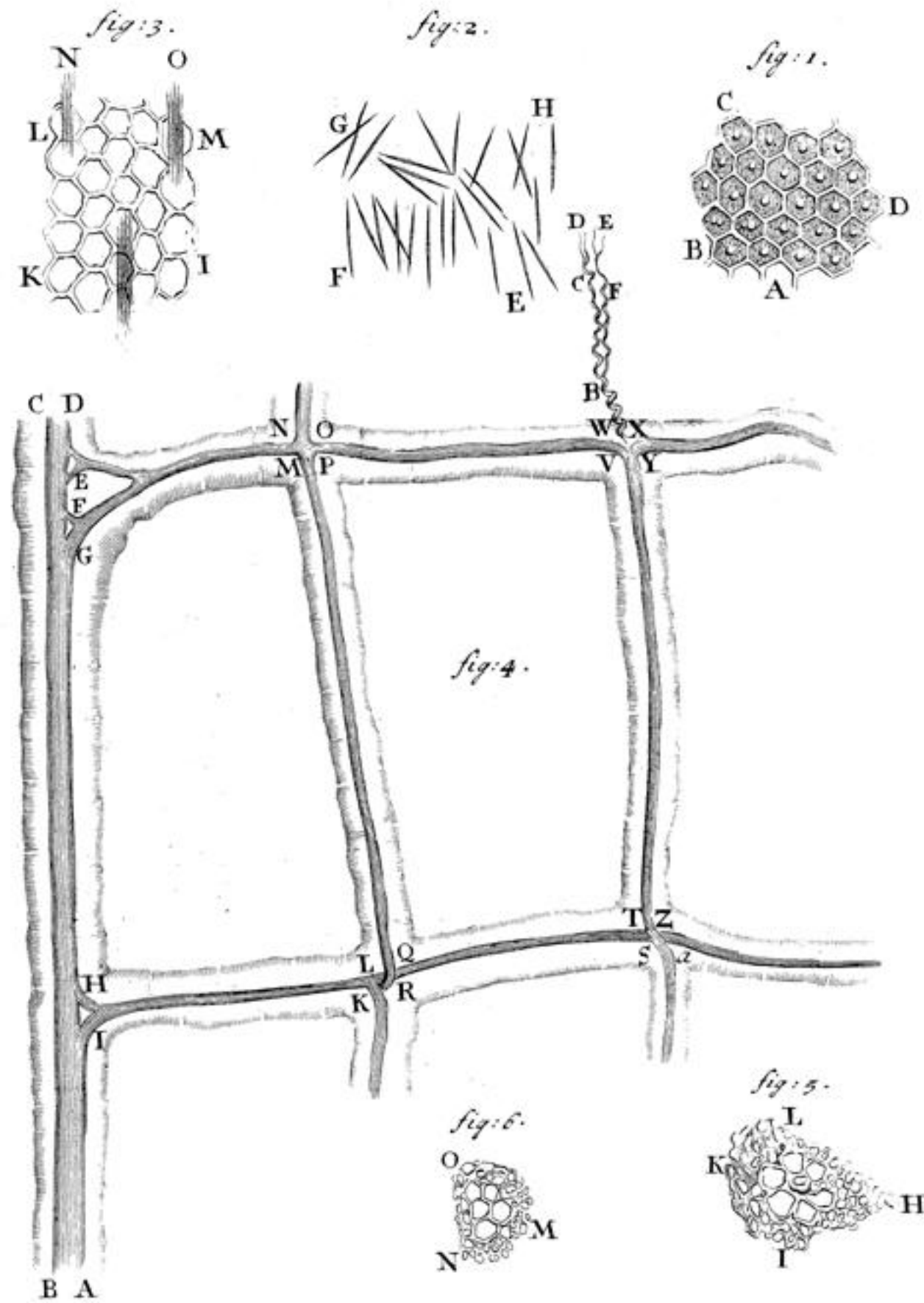
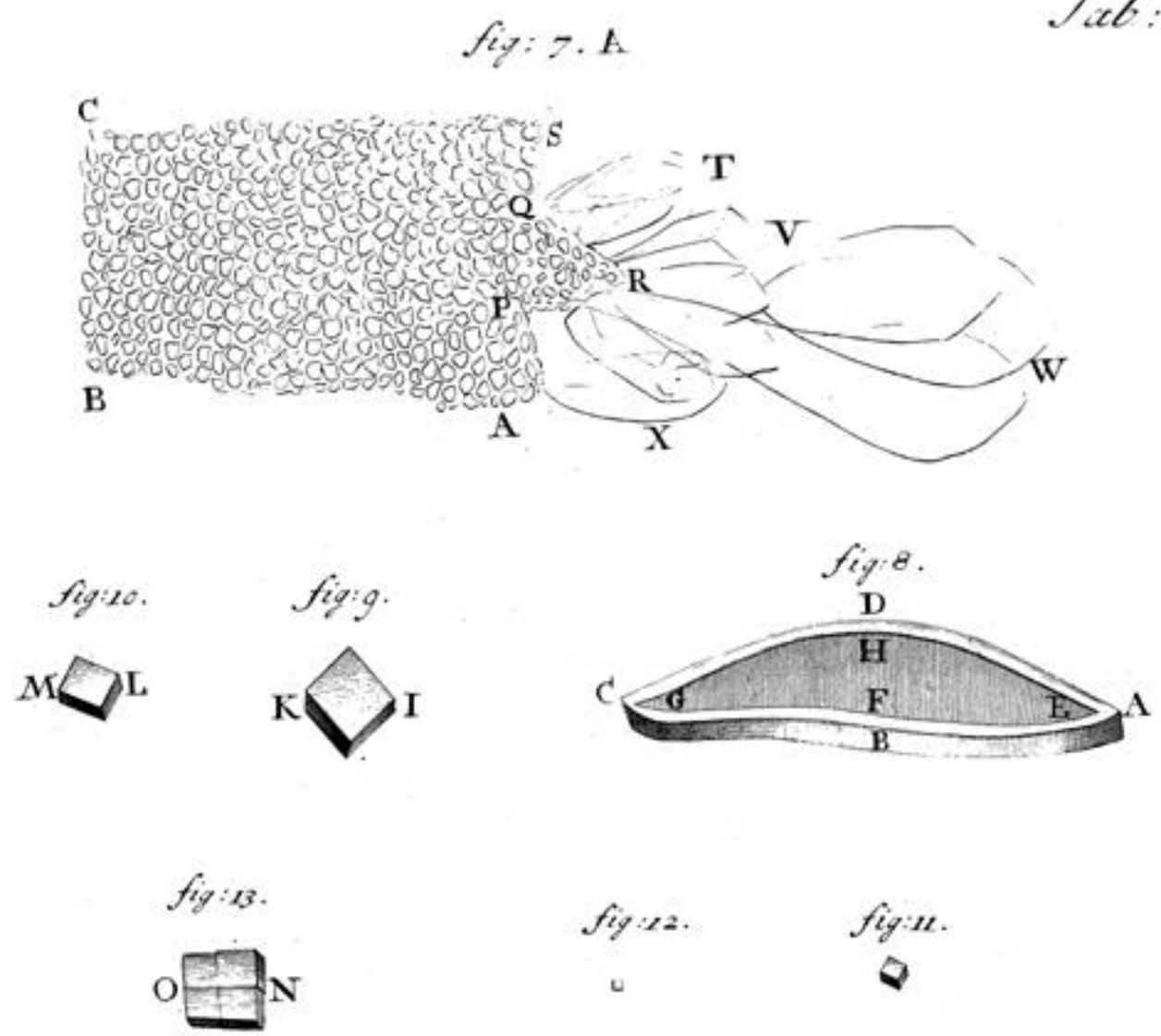
fig:5.



Tab:1.



Tab:2.



Tab:3.

