Researches tending to prove the non-vascularity and the peculiar uniform mode of organization and nutrition of certain animal tissues; namely ... cartilage ... ; the cornea, the crystalline lens, and the vitreous humour; and the epidermoid appendages / [Joseph Toynbee].

Researches

TENDING TO PROVE

THE NON-VASCULARITY

AND THE PECULIAR UNIFORM

MODE OF ORGANIZATION AND NUTRITION

OF CERTAIN

ANIMAL TISSUES;

Namely,

ARTICULAR CARTILAGE, AND THE CARTILAGE OF THE DIFFERENT CLASSES OF FIBRO-CARTILAGE; THE CORNEA, THE CRYSTALLINE LENS, AND THE VITREOUS HUMOUR; AND THE EPIDERMOID APPENDAGES.

BY J. TOYNBEE, ESQ. F.R.S.

SURGEON TO THE ST. GEORGE'S AND ST. JAMES'S DISPENSARY.

(*From the London Medical Gazette, April 7*, 1843.)

RESEARCHES

TENDING TO PROVE THE

NON-VASCULARITY AND THE PECULIAR UNIFORM MODE OF ORGANIZATION AND NUTRITION OF CERTAIN ANIMAL TISSUES,

NAMELY,

Articular Cartilage, and the Cartilage of the different classes of Fibro-Cartilage; the Cornea, the Crystalline Lens, and the Vitreous Humour; and the Epidermoid Appendages.*

By J. Toynbee, Esq. F.R.S.

Surgeon to the St. George's and St. James's Dispensary.

In the Introduction to this paper the author first speaks of the process of nutrition in those animal tissues which are pervaded by the ramifications of blood-vessels, pointing out the circumstance that even in them there is a considerable extent of tissue which is nourished without being in contact with vessels. The knowledge of this fact leads to the study of the mode of nutrition in the non-vascular tissues, which are divided into the three following classes, viz. :—

The *first*, comprehending articular cartilage and the cartilage of the different classes of fibro-cartilage.

The *second* comprises the cornea, the crystalline lens, and the vitreous humour.

The *third* class includes the epidermoid appendages, viz. the epithelium, the epidermis, nails and claws, hoofs, hair and bristles, feathers, horn, and teeth.

The author then proceeds to show that the due action of the organs, into the composition of which these tissues enter, is incompatible with their vascularity. In proof of the non-existence of blood-vessels in these tissues, he states that he has demonstrated, by means of injections, that the arteries, which previous anatomists had supposed to penetrate into their substance, either as serous vessels, or as red blood-vessels too minute for injection, actually terminate in veins before reaching them; he also shows that around these non-vascular tissues there are numerous vascular convolutions, large dilatations, and intricate plexuses of blood-vessels, the object of which he believes to be to arrest the progress of the blood, and to allow a large quantity of it to circulate slowly around these tissues, so that its nutrient liquor may penetrate into and be diffused through them. The author states that all the non-vascular tissues have an analogous structure, and that they are composed of corpuscles, to which he is induced to ascribe the performance of the very important functions in the process of their nutrition, of circulating throughout, and perhaps of changing the nature of the nutrient fluid which is brought by blood-vessels to their circumference. The author then brings forward facts in proof of the active and vital properties of these corpuscles, and concludes his Introduction by stating, that it appears to him, that the only difference in the mode of nutrition of the tissues which contain blood-vessels and those which do not is, that in the *former*, the fluid which nourishes them is derived from the blood that circulates throughout the capillaries contained in their substance; whilst, in the *latter*, the nutrient fluid exudes into them from the large and dilated vessels that

* This paper was published in the Philosophical Transactions for the year 1841, of which the present is a brief abstract.

are distributed around them: and that in both classes, the particles of which the tissues are composed derive from this fluid the elements which nourish them.

The author then enters on an examination of the structure and mode of nutrition of the several tissues of each of these three classes.

In considering the First Class, the development of Articular Cartilage is described at great length during its various stages and at the different periods of life. Numerous dissections of the ovum and fœtus are given in detail to illustrate the *first stage*, during which it is shewn that no vessels enter into the substance of any of the textures composing a joint, but that the changes they undergo are effected by the nutrient fluid from the large blood-vessels, by which each articulation is surrounded. In the *second stage* of the development of articular cartilage it is shown that the epiphysal cartilage is gradually hollowed into canals, within which blood-vessels are extended, which converge towards the attached surface of the articular cartilage: in this stage vessels are also prolonged over a considerable portion of the free surface of the cartilage between it and the synovial membrane.

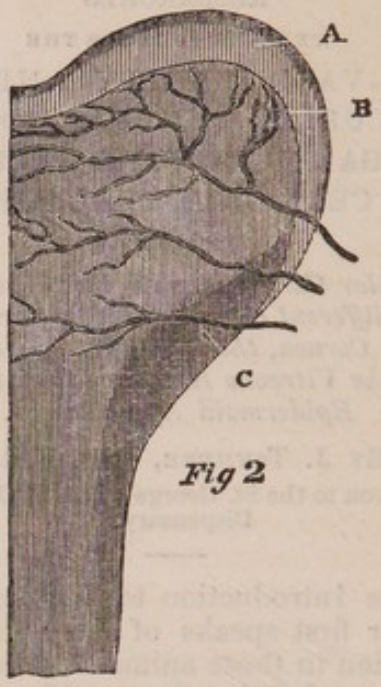
In the *third stage*, that which is exhibited in adult life, the epiphysal cartilage is converted into osseous cancelli. These contain large and very numerous blood-vessels, ramifying throughout the whole of their cavity, and are separated from the articular cartilage by a very fine but complete lamina of bone, the articular lamella, which is composed of corpuscles, and

A vertical section of the inferior extremity of the os femoris, highly magnified.

A, The impervious layer of bone (articular lamella) to which the cartilage is attached, separating the latter from the cancelli.
B, The firm vertical fibres of the cancelli implanted into the upper surface of the articular lamella.

the author believes that the principal source of nutrition to the articular cartilage is the nutrient fluid eliminated by the large vessels of the cancelli, and which permeates the articular lamella. The free surface of adult articular cartilage is nourished by vessels which extend to a short distance over its margin, and between it and the synovial membrane*. It is quite certain that the

A section of part of the inferior extremity of the os femoris, showing the relation of the blood-vessels of a bone to the articular cartilage covering it.



A, The articular cartilage.
B, The articular lamella.
C, The blood-vessels of the cancelli.

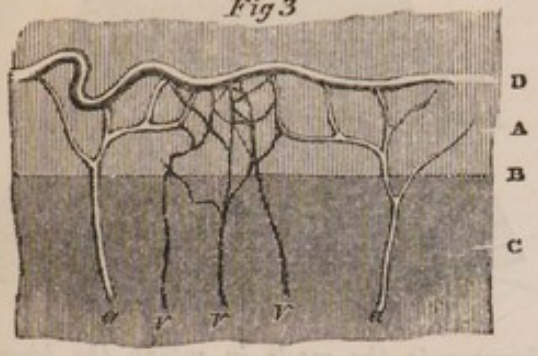
vessels thus situated do not enter the substance of the articular cartilage, inasmuch as the arteries terminate in veins at the circumference of the latter. In this situation the arteries become continuous with the veins in the following ways: firstly, by their all ending in a single vessel similar to the terminal sinus in the vascular area of the chick, from which the veins arise; secondly, the arteries terminate in dilated cavities, which give origin to veins; and lastly, the two sets of vessels are directly continuous by means of loops of various characters: the apparent object of all these modifica-

* It is very probable that synovia, a highly animalized fluid, has some share in the nutrition of articular cartilages, especially as it appears that false cartilages, without having any attachment to the synovial membrane, are developed and grow floating in it.

tions is to cause a considerable quantity of blood to circulate slowly in the vicinity of articular cartilage.

Vessels situated between the synovial membrane and the border of the articular cartilage of the condyle of the os femoris at the period of birth.

Fig 3



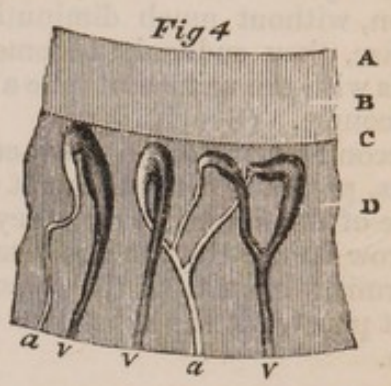
A, The articular cartilage; B, its margin; C, the synovial membrane; D, the single vessel in which the arteries terminate; *a*, artery; *v*, vein.

The author points out the presence of fine tubes which pervade the attached portion of articular cartilage: to these he ascribes the function of transmitting through its substance the nutritive fluid derived from the vessels of the cancelli, and he also shows that articular cartilage becomes thinner as man advances in life, and that this change is effected by its gradual conversion into bone, a process which is always going on.

Fibro-Cartilages constitute the second tissue of the first class: they are divided by the author into two classes; one comprising those which are not covered by a synovial membrane; the other includes those which have each surface lined by it. The structure of fibro-cartilage is carefully investigated, and in order to arrive at some definite conclusions on this subject, whereon anatomists of all ages have so much differed, he made numerous dissections of fibro-cartilages in the different classes of animals at various periods of their development, the results of which he details. He shows that this tissue is composed of cartilaginous corpuscles and of fibres; the latter preponderating in adult life, the former in infancy; and that during life the corpuscles are gradually converted into fibres. He enters at length into the question of the vascularity of these cartilages; and from a careful study of many injected specimens of man and animals at various periods of their development, the particular results of which he relates, he states that blood-vessels are contained only in their fibrous portion: these have the function of nourishing the part that is cartilaginous, which, being subject to compression and concussion, does not contain any.

A portion of the internal semilunar fibro-cartilage of the knee-joint.

Fig 4



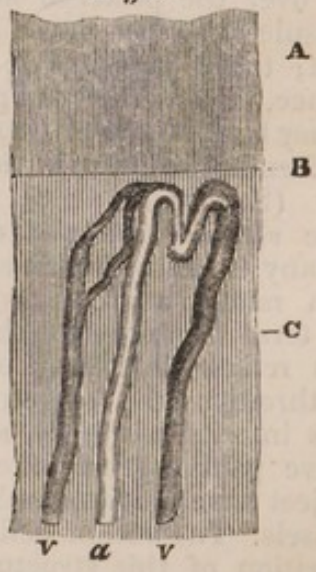
A, the free internal border of the fibro-cartilage; B, the true cartilage; C, the line of separation between the cartilage and the fibro-cartilage; D, the fibro-cartilaginous portion; *a*, the artery; *v*, the vein.

The Cornea, Crystalline Lens, and Vitreous Humour, are included in the Second Class of extra-vascular tissues.

1. The structure of the *cornea* is described as being very lax, and containing corpuscles only in a small quantity, mixed with bright fibres. The opinions in favour of its vascularity are combated, and it is shown that the blood-vessels which converge towards its circumference are disposed in two different

Represents the vessels (sclerotico-corneal) situated in the substance of the sclerotic membrane, which approach the border of the cornea.

Fig 5

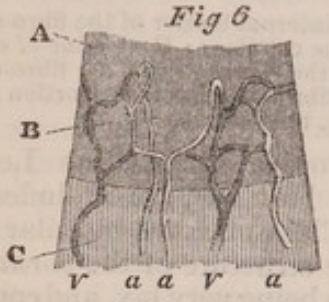


A, The cornea; B, the line of separation between the cornea and the sclerotic; C, the sclerotic; *a*, artery; *v*, vein.

ways: those which are the principal source of the fluid that nourishes it, and which from their position may be styled the sclerotico-corneal arteries, are large and numerous; they are situated in the substance of the sclerotic, and they converge to the point where this latter structure joins the cornea, in which position, without much diminution in their size, they suddenly become continuous with the veins that take a retrograde course. (See fig. 5.)

A second set, the conjunctivo-corneal arteries, pass over a small extent of the surface of the cornea, where they form a narrow band: the arteries terminate by forming loops with the veins, and do not penetrate the substance of the cornea.

Fig 6



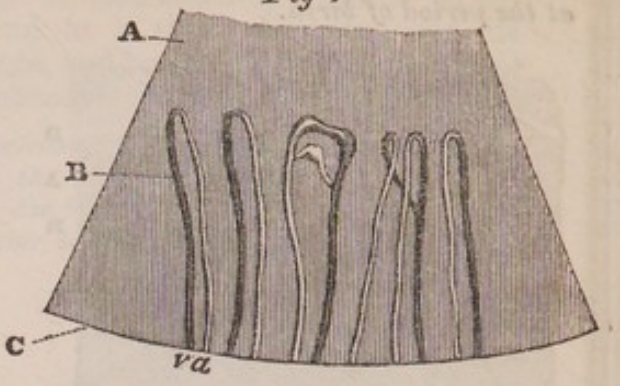
Represents the vessels (conjunctivo-corneal) which pass to a certain extent over the surface of the cornea, between it and the conjunctiva.

A, The cornea; B, the conjunctivo-corneal vessels; C, the sclerotic; *a*, artery; *v*, vein.

2. The *crystalline lens* is described as being composed of corpuscles of which the radiating fibres are constituted. The arteria centralis retinæ is the source of nutrition to this organ; it ramifies over the posterior surface of the capsule in the form of large branches; these pass round the circumference, upon the periphery of which they become straight, and terminate by forming loops with the venous radicles. (See fig. 7.)

3. The *vitreous humour* does not present any traces of vascularity, and although many anatomists have in general terms represented the arteria centralis retinæ as giving off in its course through the organ minute branches into its substance, still those who have paid especial attention to this subject have not been able to find such vessels. The author believes that the nutrition of this structure is accomplished by the vascular ciliary processes of the choroid, and that the fluid brought by the latter is diffused through its substance by means of the corpuscles of which its membrane is composed, assisted by the semi-fluid character of the humour.

Fig 7



Represents the mode in which the blood-vessels are distributed that nourish the crystalline lens. Human fœtus.

A, The anterior surface of the lens; B, terminal branches of the arteria centralis retinæ; C, the circumference of the lens; *a*, artery; *v*, vein.

The Third Class of extra-vascular tissues comprehends the Epidermoid Appendages. The author describes them all as composed of corpuscles, which are round and soft where they are in contact with the vascular chorion, compressed and flattened where they are farther removed from it. He points out, in the substance of the hoof of the horse, the existence of fine canals, which he supposes to conduct fluid through its mass; and he states that the perspiratory ducts of the human subject possess a structure analogous to the spiral vessels of plants. The author describes each of the tissues of this class, and shows that the various modifications presented by the vascular system with which each is in contact have the sole object of enabling a large quantity of blood to approach and circulate slowly around them. He also points out, in connexion with this subject, the remarkable vital properties which are possessed by these non-vascular tissues.

In the conclusion to this paper, the author states that his object has been to establish as a law in animal physiology, that organs are capable of being nourished, and of increasing in size, without the presence of blood-vessels in their substance.

The application of the above-named law to the study of *Surgery*, in reference to the causes of the

extension of vessels into the extra-vascular tissues when in a diseased state, and to the measures to be adopted for the prevention and cure of those affections which are dependent thereon, and to *Pathology*, in the investigation of the nature of morbid structures, particularly of those classes which contain no blood-vessels, will, the author feels certain, be productive of scientific interest, and of practical advantage.

WILSON AND OGILVY, 57, Skinner Street, Snowhill, London.