The Vascular System, viewed normally

The vascular system is the channel by which a stream of nutritive fluid, or living blood, is transmitted to the various tissues of which the human body consists, permeating numerous exquisitely formed organs in every direction, supplying them with nourishment, equalizing the flow of blood to the different parts, and thus enabling them to perform their functions aright.

While the blood continues to flow, the body continues to live, but with the final stoppage of this vital stream, life becomes extinct.

Practically speaking, its stoppage of the circulation is tantamount to the extinction of life, although the nature of life is altogether unknown, yet we find its existence in all living beings to be intimately confederated with the constant
transmission of a nutritive fluid throughout their substance. Different opinions have been expressed with regard to the definition of life—Aristotle calls life nutrition.—Beclard calls it organisation in action. Two opinions have been held, with regard to it—
1. That life is a vital principle or cause.
2. That it is a result.

Life precedes organisation and its product.
This may be illustrated by taking two seeds, one an Apple, the other a Pear. It is impossible to distinguish the one from the other by merely looking at them, but plant them in the ground, where they will receive moisture, air, and the other requisites necessary for the process of germination; one will become an apple tree, the other a pear tree. Leaving this and turning our attention more particularly to the subject, which we preferred to treat off, we find the Vascular system to consist of a Heart, Arteries, and Veins, with intermediate vessels usually termed
Capillaries, through which channels the blood is prop- 
elled, by the action of the Heart and the elasticity 
of the arteries. — The Arteries conduct the blood from 
the Heart to the different regions of the body, while the 
Veins convey it back to the heart again. — Before 
the arterial blood can be transformed into venous 
blood, it behaves it to pass through the intermediate 
set of vessels, which connect the extreme branches of 
the arteries, with the commencing branches of the veins 
they consist of a very fine set of tubes which are very 
indefinately marked off, from either. —

The Arterial system is subdivided into Pulmonary 
and systemic arteries, the former (by the contraction 
of the Right ventricle) conveys the blood from it to the 
 lungs, where passing through the capillary vessels 
of these organs, it is subjected to the requisite chang 
in other words oxidied, fit for immediate circu-
culation, it then enters the commencing branches of 
the Pulmonary vein, which, terminating by four 
trunks in the left Atrium, convey it into that cavity
where it is immediately discharged into the left
Ventricle. — The flow of the blood from the Left
Auricle, into the Left Ventricle, produces slight ex-
cretesion which acting as a stimulus causes the
L. Ventricle to contract, propelling the blood into
the latter series of vessels, or (main trunk of the sys-
tematic arteries) by which it is conveyed to all
parts of the body. — It will be right before en-
tering upon the consideration of the composition
of the blood, changing which it undergoes in its pas-
age through the body, to proceed to the description
of the Heart, and what we may term its appendage.

But before doing so, let me state that in attempt-
ing to describe the different organs of circulation,
I do not intend to enter into any detailed account,
but merely to state general facts which are known
to everyone, who is at all acquainted with the
Anatomy and Physiology of these organs.

Nor can I conceive how I could proceed otherwise
if I could so far presume one who is inunbed
in the intricate channels which lead to discovery without practical experience, to try to penetrate into its recesses, I should certainly be forced to beat a retreat without achieving the object that in view. — Metaphorically speaking, you may as well put an inexperienced sailor, or one just serving his apprenticeship in command of a vessel, in a gale of wind, on a lee shore, tell him to conduct her out safely to sea. — In expressing my opinion thus freely, I do so in the belief that it will be appreciated & respected, and not construed into negligence or indifference on my part. —

Heart — The heart is generally regarded as the centre of the whole corporeal frame, the fountain of life which is designed to pour out its vital streams to every part of the system, supplying it with nutritive materials, maintaining the functions of the different organs, and uniting them however different in their nature and operations into one harmonious whole.
The heart, situated in the anterior part of the thorax, is a conical hollow muscular mass, suspended from its base by the great blood vessels, which form the main trunks of the lusciferous system, and enclosed in a membranous sac called the pericardium.

Its position in the chest is obliquely from right to left, its base or wider part being directed upwards, and to the right, its apex to the left side of the cavity. Thus inclined it lies between the right and left lungs occupying more of the latter than of the former, owing to its inclination to the left of the median line.

As aforesaid the general form of the heart, is that of a blunt cone, flattened on its posterior or under surface resting on the diaphragm. The anterior surface is convex in its general form; it is turned upwards as well as forwards, directed towards the sternum and costal cartilages, from which however it is partly separated by the lungs, these advancing over it during inspiration, leaving very little uncovered.

The two margins or borders formed by the junction
of the anterior and posterior surfaces, and named respectively the right and left margins, or the margins acute and margin obtuse, differ considerably in appearance, as their technical names would seem to imply, the former being comparatively thin and longer than the latter, which is more rounded.

The heart is a hollow muscular organ, divided into four compartments, by septa which traverse its interior; these compartments are named auricles and ventricles, the former being situated at the base, the latter at the apex of the heart. In the adult and fleshy state of this organ, there is no direct nor indirect communication between its right and left sides, that is between the two auricles, and the two ventricles.

As regards the non-communication of the auricle, however, we cannot be so dogmatical, the above principle must be taken with some limitations, as it appears the passage between them in the fetus, called the foramen ovale, is sometimes not entirely occluded, even long after the period of infancy.
When we come to consider the circulation of the blood through the animal system, we will refer more particularly to the difference existing between that of the fetus and adult, but in the meantime let us content ourselves with the description of the heart as we find it in its fully developed state.

Though no distinct communication exists between the auricles and ventricles of opposite sides, yet, as one would naturally suppose the auricles of ventricles of each respective side, communicate with one another by an aperture, termed the **Auriculo-Ventricular Openings**, these Openings are provided with valves, in order to prevent the reflux of blood into the auricles that would necessarily occur on the contraction of the ventricles.

Besides these apertures, for the direct communication between the auricles and ventricles, other apertures exist between these internal cavities and the organs to which the blood is first expelled or from which it is received, after having under-
gone the change due to circulation, or necessary for circulation. Thus the right auricle possesses apertures through which the dark venous blood is received, when returned by the two Vena Cava, and other small veins. The right ventricle communicates with the pulmonary artery for the conveyance of the blood to the lungs. While the left auricle is in communication with the pulmonary veins, and the left ventricle with the great systemic artery, through which the blood is propelled into the body. All these apertures of communication are guarded by valves, with the exceptions of the pulmonary veins, superior Vena Cava, and some of the smaller venous orifices, so as to prevent the regurgitation of the blood back into the vessels, that would ensue on the contraction of the Auriculo-Ventricular cavities. The structure of the mechanism of these valves will be better explained after a consideration of the structure of the heart in detail. The heart consists principally of muscular tissue which is attached to certain
fibrous structures, and covered externally by a serous membrane, which is the reflected or visceral portion of the pericardium; internally the cavities are lined by a thin transparent membrane termed the endocardium, which is continuous with the living membrane of the arteries. — It varies in thickness in different places of these cavities, and on the whole it is said to be thicker in the auricles, than in the ventricles. — The walls of the heart are supplied with blood-vessels, absorbents, and nerves, and also more or less fat with some cellular tissue. —

The pericardium as I have already mentioned, is that membranous sac, by which the heart is enclosed, and also the commencement of the large vessels connected with it. — Its description agrees with the heart as far as regards its shape (being a cone), but differs from that organ in its parts being separately related, the base of the pericardium being in position to the apex of the heart, and attached to the upper surface of the diaphragm, whilst the
The apex surrounds the great vessels springing from the base of the heart. In consequence of this arrangement, the heart is suspended in the pericardiac cavity, which covering serves to prevent any sudden or extensive displacement, which might interfere with its proper action.

The pericardium is a fibro-secrous structure composed of two membranous layers, one external and fibrous, the other internal and serous. The external or fibrous layer, consists almost exclusively of white fibrous tissue, interlacing in every direction. The fibres at its base become commingled with those of the central appendices of the diaphragm, while at its apex, the fibrous layer extends along the large blood-vessels in the form of tubular prolongations, becoming gradually lost on their external coats.

The external or serous layer is analogous to those of its own class, representing a simple one portion of it invests the internal surface.
of the fibrous pericardium, while the other or visceral portion covers the heart, the line of reflection passing over the great vessels at the base of the heart.

The fibrous structure of the heart consists of rings which surround the auriculo-ventricular, and arterial orifices, giving attachment to the muscular fibres of the auricles and ventricles, and also to the base of the valves. In addition to this the fibrous tissue enters into the formation of the valves, and chorda tendinea. All of these fibrous structures are most strongly developed on the left side of the heart. The manner by which the commencement of the large vessels (pulmonary art.) is fixed to the tendinous rings surrounding these orifices, is worthy of notice. These rings as already said, consist of fibrous structure, one edge of which is even, and gives attachment to the muscular fibres of the ventricles, whilst the other is excavated into three deep semi-circular notches, extending nearly to its ventricular edge.
These semi-circular margins are much thicker and stronger than the rest of the tissue; they receive the corresponding convex margins of the middle coat of the artery. In this part of the artery, its middle coat is thinner, and the sides of the vessel slightly dilated to form the aneurysm of Val- 
usala. — Here also, we observe the parts of the middle coat to have a peculiar arrangement; instead of being annular, they appear to diverge from the projecting parts of the tendinous rings and spread out upwards and laterally upon the walls of the vessel. — In the same situation, the cellular coat of the artery is thin, but the connexion of the vessel to the heart, is strengthened by the serous layer of the Pericardium without, and by the Endocardium within. (Sharpey).

Having now considered the fibrous structure of the heart, I now propose to treat of the Muscular tissue of the Heart. —

The muscular substance which constitutes
the principal portion of the walls of the heart, consists of bands of fibres, interlacing each other in an intricate manner, and in this way adding greatly to the power of resistance possessed by that organ. — The muscular fibres belong to the involuntary class, but are pale red colour, and are more marked with transverse strie, being closely analogous to the striped fibres of the external muscles.

They differ however from the fibres of the external muscles, not only in belonging to those of the involuntary class, but also in regard to the quantity of cellular tissue. In the heart there is little or none of that areolar tissue, which exists in considerable quantity in the external muscles, uniting their fibres together; the fibres of the heart adhering together mainly by their interlacement. — The auricular and ventricular fibres are quite independent of each other, they being connected only through the interposition of the fibrous rings around the auriculo-
ventricular orifices; this may be ascertained by boring a heart for some time, when these rings become destroyed, in this way the auricles may be easily separated from the ventricles.

And first with regard to the fibres of the auricles. In the examination of the auricles we observe two sets of fibres, one superficial and common to both auricles, the other deep-seated and proper to each. The superficial fibres run transversely over both auricles; they are found principally on the anterior surface, embracing them like a belt, but are scarcely visible on the posterior surface. The deep or proper set of fibres are arranged in two different ways, viz. looked annular. The former pass over the auricles, and are joined by both extremities to the corresponding auriculo-ventricular rings. The latter encircle the auricular appendages from end to end; some longitudinal fibres running within them. These auricular fibres surround the Venous orifices of the auricles, and
extend along their trunks to a considerable distance.

II. Fibres of the Ventricles. — Though the fibres of the Ventricles may be regarded as dividing themselves, into a superficial and deep set, as is the case with the auricles, yet their arrangement is much more intricate, and the description of them attended with greater difficulty than that of the auricles. — The mode by which these fibres are attached seem to be somewhat similar to those of the auricles; being connected either directly or indirectly to the auriculo-ventricular fibrous rings, or into those surrounding the arterial oriﬁces.

The Superficial Fibres. — assume a twisted or spiral appearance. — On the anterior part of the ventricles, they run obliquely from above downward, and from right to left; whilst those posteriorly become more vertical, and incline from left to right. — These ventricular fibres differ from one another as regards their length, the superficial fibres being longer than those which are situated
beneath them; and it is found that on reaching the apex of the heart, they coil round, and dipping up beneath the border of the next deeper chamber, pass into the interior of the ventricles, then ascending, spread out upon the inner surfaces of these cavities. — They form what is called the vortex, by their arrangement as they are about to penetrate the apex of the heart. — The fibres which are placed beneath the upper stratum layer, have a similar arrangement as those described above, diminishing in length, and forming shorter lobes as they proceed from without inwards. — Having reached the interior of the ventricles in the manner already described, they pass up to form the wall, septum, and the musculi papillaries of those cavities, being ultimately attached to the auriculo-ventricular tendinous rings, either at once, or through the intervention of the larger Chorda tendinea. — These special set of fibres seem to be of two kinds which may be termed Common and Propar.
The latter pass in or out at the interventricular furrows before and behind, turning round one, or the other ventricle; whilst the former pass over the furrows, and embrace both cavities, the greater number passing across the posterior longitudinal furrow.

The Deep set or Circular fibres of the ventricles are situated near the base of these cavities; they are somewhat analogous to those of the superficial set in their mode of arrangement; some fibres dip into the anterior and posterior longitudinal furrows, whilst others pass across to the opposite side, entering the substance of the ventricle, where they turn up towards the tendinous rings at the base. Those fibres of the Deep set which pass across the ventricles, are seen to be more abundant on the posterior, than on the anterior surface.

These remarks regarding the arrangement of the muscular fibres of the Heart (both in the auricles & ventricles) have been more or less derived from
the writings of Dr. Sharpey, who quotes largely from the description given by Dr. J. Reid in his Cyclopaedia of Physiology.

Having thus briefly described all that is worthy of notice on the external aspect of the heart, I will for a little advert to the Mechanism & Structure of some of those parts observed in the interior of the heart. On laying open each ventricle, we find it to consist of two distinct parts; one in direct communication with the auricle, through means of the large and free aperture of the auriculo-ventricular orifice, through which the blood passes from the auricle into the ventricle; the other is a funnel shaped cavity which is in communication with the artery, and termed the Infundibulum, through which the blood is expelled into the artery from the ventricle. The auriculo-ventricular orifice in each ventricle, is guarded by certain valves, which when not in action, lie in the ventricles. The value of each side differs from
that of the other, in the number of portions, of which each consists. — The valve of the left side consists of two triangular curtains, whilst the valve of the right side consists of three. — They are named respectively Initial and Semicircular values.

From the free margins and part of the ventricular surfaces of the two triangular portions, of which the Initial value consists, tendinous chords (chordae tendineae) pass to various points of the wall of the ventricle. — The bases of these curtains are attached along the fibrous zone which separates the auricle from the ventricle, the larger curtain being so placed as to separate the infundibulum from the ventricles.

The Semicircular Valve. — This valve guards the orifice on the right side of the heart, between the auricle and ventricle, it consists of three portions, each having a pointed free extremity extending into the ventricle, and connected to its walls, by tendinous chords. — The base of each
segment is attached to the fibrous zone, which intervenes between the auricle and ventricle.

The largest curtain of which this valve consists, is situated anteriorly, and the next ridge corresponds to the infundibulum of the ventricle. Each of the arterial orifices of the ventricles, are guarded by three semilunar valves, to prevent the regurgitation of the blood into the ventricles.

Whilst the blood is flowing from the ventricles, these valves lie flat against the wall of the artery; but immediately, as the blood regurgitates towards the ventricle, they are pushed by it towards the mouth of the artery, and being placed in close apposition to one another, oppose the return of the blood. These valves present nearly the same general appearance as those already described, with the exception that in the centre of the free margins of these valves, is placed a small round body of fibrous tissue, termed Coferus Arantii.

The valves of the pulmonary artery are quite
analogous to those of the aorta in form and structure, the latter, however, being the stronger of the two.

When we examine the interior of the ventricles more particularly, we observe them to be covered by numerous fleshy bands, termed columnae carnea; which are usually described as consisting of three kinds. — The first order merely forms slight prominent ridges, adhering in their whole length to the walls of the ventricles. — The second are attached at both extremities and free in the middle; whilst the third kind are attached by one extremity to the walls of the ventricles, the other extremity which is free projects into the cavity; the latter are designated by the name of musculi papillaries; from the extremities of which arise the chordae tendineae, which ultimately become inserted into the mitral and tricuspid valves, and a few into the wall of the ventricle.

These columnae carnea are entirely confined to the cavity proper of the ventricle; the surface of the
come artiœriœs being perfectly smooth, free from
them. — The two ventricles are closely symmet-
crical in their internal appearance, by that I mean
that the description of the one would serve for the
other, with one or two exceptions, the only one worthy
of mention is the thickness of the walls, the left
ventricle being accounted by some to be twice, and
even three times as thick as that of the right
ventricle.

The muscular walls of the auricles are compara-
tively thin, and of a somewhat cuboidal shape.

In commencing the examination of the right
auricle, an incision is generally made, which ex-
tends between the two vena cavae, uniting them
into one, and in this way the interior of the aur-
icle is fully exposed. Each communicates
with its respective ventricle by a wide orifice,
but is separated from its fellow by a thin flesh-
y septum, which is nearly translucent at its
middle. — Each auricle consists of two
distinct portions; the Sinus venosus which is by far the largest portion, and the Aunicular appendage which resembles somewhat the shape of a dog ear, projecting forwards on each side of the aorta and Pulmonary artery. These two portions are in direct communication with one another, but the blood is only received from the veins by the Sinus venosus. The veins which pour their blood into the Sinus venosus are three in number viz. the two Vena cavae, the coronary vein or the Vena trunca of the heart. The site which they occupy and the angles at which they are inclined to the auricle, as they open into its interior differ greatly.

The Sinus Vena cavae open into its upper angle passing downwards and forwards; the Sinus Cava opens into its lower angle passing upwards backwards and inwards; whilst the coronary vein opens between the Sinus cavae and the auricle ventricular orifice. On turning the attention more particularly to the appearance
presented by the interior of the auricle; the eye of the examiner is at once directed towards several prominent muscular fasiculi on its outer wall, interlacing with each other, and which are named musculipectinati. On the septum between the auricles is seen a depression named fossa ovalis, nearly surrounded by a ring termed annulus ovalis, which depression is the vestige of the foramina ovale, which existed during intra-uterine life.

To the left of the orifice of the Inf. Vena Cava, is the Bustachian valve, which, though comparatively small in the adult, is proportionally large in the fetus, and serves as we shall see to direct the blood of the Inf. Vena Cava, towards the foramen ovale. It consists of a duplicature of the lining membrane of the auricle, of a semilunar shape, which projects between the Vena Cava and the Auriculoventricular orifice. The orifice of the Coronary vein is guarded by a small valve called the valve of Thebesius. Several other small orifices
are seen, which have received the name of foramina Thebæii. — Some are the mouths of minute veins, others are merely depressions in its walls.

The Left Auricle — like the right consists of two distinct portions — the sinus venosus, and the auricular appendage. — The pulmonary veins (four in number) open into the left auricle, and are entirely without valves. — The lining membrane of the interior of the left auricle is perfectly smooth, but less transparent than that of the right. — On the septum between the auricles, there is observed a depression which is all that remains of the foramen ovale, as it appears on the left side. — The cavity of the sinus venosus is smooth, but the inner surface of the auricular appendage presents the same appearance as was observed on the right, but in a less degree. — The left auricle is situated in the concavity of the aorta, and is almost concealed by the aorta and pulmonary artery lying in front of it.
The substance of the Heart receives its supply of blood from the aorta, through the two coronary arteries, which spring from the vessel just beyond the margins of the semi-lunar valves. They take opposite directions one passing in front, the other behind the heart, ultimately intermingle with one another, each giving off a branch at the grooves between the ventricles, which pass towards the aorta where they anastomose with each other.

The blood is returned to the right auricle by means of the coronary vein already considered.

The nerves of the heart are derived from branches of the Vagus, and sympathetic, which go to form the cardiac plexuses, and from which the heart is supplied.

Action of the Heart. — In order that the circulation of the blood through the body might not be brought to a stand, it is quite evident, that the heart’s action must never cease, but as a period of rest is essential for the perfection of
all muscular action, it may be truly said that during the long pause, the relaxation of the heart is quite passive. — During this time the auricles are gradually filling with blood flowing into them from the veins; a portion passes directly through into the ventricles, the auriculo-ventricular opening during all the pause being free of patent. — The auricles however receiving more blood than at once passes through them to the ventricles, become fully distended near the end of the pause, at the termination of which they contract, and empty their contents into the ventricles. — The contraction of the auricle is very quick and sudden, it commences at the entrance of the great veins into them, and is then propagated towards the auriculo-ventricular opening in an undulatory movement; the auricular appendage being the last part that contracts. — The effect of this contraction is to propel nearly the whole of their contents into
the ventricles. — The blood which is thus driven by the contraction of the auricles into the ventricles, being added to that, which had already flowed in during the heart's pause, is sufficient to complete the distension of the ventricles. — Thus distended, they immediately contract, so rapidly, that their contraction looks as if it were continuous with that of the auricles. — They contract much more slowly than the auricles, and simultaneously in every heart, the whole wall of each ventricle being drawn up uniformly towards the origin of the artery at its base, diminishing the cavity in every diameter but especially in length, so that the heart assumes a shorter and more globular form than it had in the relaxed and distended state of the ventricles. — In this complete and uniform contraction, the ventricles probably always empty themselves, differing in this respect from the auricles, which even after their complete
contraction, retain a small quantity of blood. (Dr. Bennett)

Certain sounds accompany the heart's action, the right interpretation of which, evolves the state of that organ, and enables us to arrive at a more accurate diagnosis, when in a state of disease, than we could otherwise do. — On placing the ear over the region of the heart in a healthy individual, two sounds are heard following in close succession to one another, but differing in the degree of sound emitted, and in the proportion of time occupied by each sound.

The first sound is heavy, deep, and somewhat prolonged, synchronous with the impulse, and contraction of the ventricles; it is best heard over the apex of the heart — it is also termed the systolic sound.

The second or diastolic sound, which immediately succeeds the former, is sharper, shorter, and more superficial; it is best heard over the base of the heart, nearly on a level with the third diaphragmatic rib.
The duration of the first sound is nearly double that of the second, while that of the second, is equal to the pause. Thus dividing the whole time of the heart's action into four parts; the first sound is said to occupy the first two parts—the second, the third part, and the pause the remaining fourth part.

Causes of the Sounds of the Heart.

The first sound may be said to be dependent on the combination of four different acts.
1. Contraction of the ventricles.
2. Slapping together of the auriculo-ventricular valves.
3. Rushing of blood through the aortic orifice.
4. The impulse or striking of the heart valves against the thoracic walls.

The second sound is caused by the slapping together of the sigmoid valves.

These sounds are liable to become modified in various ways, that may be illustrated by the following examples; when the ventricles become
Hyperstrophic, the sound conveyed to the ear is dull, and vice versa when the ventricles are unusually thin, the sound is peculiarly loud and clear.

Cause of the Respiration of the Heart.

When the heart contracts, its apex impinges against the periosteum of the thorax.

What is that owing to? It is generally supposed to be due to the peculiar arrangement of the muscular fibres. Their general direction is from right to left, the great mass of which mass meets the apex of the left ventricle, and assist in forming the muscular columns within it.

The fibres on the front of the heart, and on the right side of the left ventricle, being much longer than those on the back and left side of it, will contract most, as they all draw up towards the tendinous rings; in their contraction, they tend to draw the apex forwards and upwards, and probably also by their spiral turning round the apex, a slight rotary movement may be imparted to the heart.
from the left towards the right side of the chest. Thus we see, the impulse is due to the mode of contraction caused by the peculiar arrangement of the muscular fibres.

Nervous Influence on the Action of the Heart.

The nerves by which the heart is supplied, are branches derived from the par-vagus, and sympathetic nerves. That the heart is influenced through means of these nerves is certain, from what we see in cases of mental emotions or shocks, where the action of the heart is either modified or arrested. When the influence of a shock of electro-magnetism (as recorded by T. H. H. Heber) is conveyed to the heart through the sympathetic nerve, it seems to accelerate the action of the heart, but when done through the par-vagus, it becomes retarded. The force by which the left ventricle contracts, is double that of the right, this is due to the greater thickness of its walls. The force of the auricular contractibility has
not been ascertained (vermepall, notes from D. Bennett).

Having thus minutely described the structure and mechanism of the various parts of which the heart consists, I will now endeavour to give a description of the other parts connected with the vascular system in as concise a manner as possible.

I. Arteries. These vessels were so named from the notion that they contained air.

Hippocrates and his contemporaries applied the term artery exclusively to the trachea, from the circumstance of it containing the air, which it transmits to the lungs, describing the vessels now called arteries as pulsating veins.

It is chiefly to Galen, that we are indebted for the reputation of this error, which at that time had long prevailed in the schools of medicine; he confidently asserted that the vessels now termed arteries, though for the most part found empty after death, contained blood in the living body, and
described the arteries and veins as forming each a tree, whose roots implanted in the lungs, and whose branches distributed throughout the body were united by a common trunk in the heart.

The term artery is now applied to those vessels which are the active agents for the conveyance and distribution of the blood, from the heart to the various parts of the body.

There are two great Arterial trunks viz. the Aorta, and Pulmonary artery, which arise respectively from the left and right ventricles of the heart.

In their transit through the parts allotted to each, they give off branches, which divide and subdivide in an arborescent form, until they become reduced in size, to the most delicate minuteness, when they constitute the so termed capillaries.

The arteries in general become smaller in their course, in proportion to the number of branches arising from them. — In this however there are exceptions; as is observed in the case of the
aorta, from the thoracic portion, to near its bifurcation into the iliac vessels; also the vertebral arteries, from their origin to the foramen magnum of the occipital bone; each vessel being of the same size throughout, although branches are given off in their intermediate course. — The form of the arteries as a general rule is cylindrical, though this is by no means accurately preserved. — Some arteries increase in size in the progress of their course. — Examples. — The umbilical arteries, which expand as they approach the placenta, and also the spermatic arteries, which enlarge considerably as they proceed to their destination (especially in the ram & bull.) — The arteries by repeated divisions become smaller and more numerous, yet the combined area of the branches of an artery, exceeds that of the trunk from which they are derived, and consequently the capacity of the arterial system as a whole is increased, in proportion to the number of its divisions.
When the bifurcation of an artery takes place, the largest branch usually continues its course in the direction of the original trunk. The angle at which the branches are given off from the trunk of the vessels, varies in some instances, for the most part they are given off at an acute angle; others, as the Sublumbar intercostal, at an obtuse angle; whilst the Lumbar arteries from Aorta, at right angles. Arteries usually pursue a tolerably straight course, but in some parts they are tortuous. Examples of this in the human body are afforded by some of the viscera, as the Stomach, Intestines, Omentum. This disposition seems to be a provision for the prevention of obstruction to the circulation, which might result from the great and sudden changes to which they are liable. The physical effect of such a condition of the vessel on the blood flowing along it, must be to reduce the velocity by increasing the extent of surface over which the
blood moves, and consequently the amount of friction; still it does not satisfactorily appear why such an end should be provided for, in the several cases in which arteries are known to follow a tortuous course. (Dr. Sharpey).

When arteries unite they are said to anastomose or inseminate. This may be seen to take place more or less in every part of the body in large arteries as well as in small vessels, though much more frequently in the smaller vessels.

We have examples of this insemination, occurring around the surfaces of joints, in the hands, mesentery, brain, &c. and besides these, in all those organs whose delicacy of structure, requires an exact and adequate supply of blood, for the right performance and maintenance of their several functions. By reason of this anastomosis, the circulation is carried on in a limb, after its chief arterial trunk is obliterated by disease, injury, or surgical operation, and it
is to this well established fact, that surgeons are enabled to perform many of their most capital operations with beneficial results.

The course of the arteries is generally on the flexor surfaces, and on the sides least exposed to injury.

**Structure of Arteries.**—For the most part the arteries are enclosed in a cellular sheath, but in such a loose manner that their motions on its inner surface are not at all obstructed.

So this looseness is due the readiness with which the vessels retract within their sheaths, when cut across. The varieties of arteries are generally divisible into three coats, viz. external, middle, and internal, this division is quite sufficient for all practical purposes—although they are described by Henle and also Dr. Bennett to be composed of 6 coats—

II. The Penetrated—III. IV. constitute the middle coat, consisting of longitudinal, and transverse striae.

V. The Elastic—VI. the Cellular.
The three coats of the artery vary in thickness according to the size and capacity of the vessel.

The external tunic.—consists of condensed cellular tissue of a whitish colour, with fibres interlacing each other at obtuse angles to the length of the vessel.—This tunic is loose on its external surface, and slightly connected to the sheath of the vessel by delicate fibres.

Its internal surface is in close apposition to the middle or muscular coat.—

The middle coat—consists of dense firm fibres, of a reddish-yellow colour, disposed somewhat obliquely round the vessel, becoming at last lost in the neighbouring fibres.—It is to the firmness of this tunic that the circular form of the arteries is preserved.—A slight degree of strength and elasticity is inherent in this muscular coat, both in its longitudinal and circular direction; but particularly in the latter.—These properties are said to diminish
ich progressively from the larger to the smaller arteries. — The internal tunic is the thinnest of the three coats, its inner surface in the living body is smooth and polished, and is an admirable adaptation, whereby the effect of friction in diminishing the velocity of the blood through the passages, is merely nominal; it is continuous with the lining membrane of the heart, and is almost inelastic and brittle. —

Physical properties. — These are considerable strength, and a very high degree of elasticity, being extensible and retractile, both in their length and width. — When cut across, their orifices though empty remain patent, the veins on the other hand collapse, unless when prevented by connexion with surrounding rigid parts. — The vital contractility of the arteries is seated in the middle coat. — The functions of the arteries are, — 1. The conveyance and distribution of the blood to the different parts of the body. — 2. The equalization
of the flow, and the conversion of the pulsatile jetting movement given to the blood by the ventricles, into the uniform flow. 3. The regulation of the supply of blood to each part.

Next in succession to the Arteries, are the Capillaries. It was pointed out by Harvey that the passage of the blood from the Arteries into the Veins, constituted a necessary fact of the doctrine of circulation, but the mode in which this took place was not ascertained until some time after the date of his great discovery. The discovery of the capillary vessels and of the course of the blood through them, belong to Malpighi, who, in 1661, by the application of the microscope clearly demonstrated the now accepted fact. Structure of Capillaries.

They consist of tubes of homogenous membrane, studded here and there with nuclei of a more or less oval form, and placed generally with their long axis corresponding with that of the vessel. The diameter of the capillaries vary somewhat
in the different textures of the body, the average eye being from 200 to 300 or an inch. The smallest occur in the brain, and the largest, in the skin, and medulla of bones. The form of capillary network presents considerable varieties in the different textures of the body. The chief shapes of the meshes are the rounded and the elongated. The round occur in the skin, lungs, and most glands, also in mucous membranes; the elongated meshes are observed in parts, where the vessels are arranged among bundles of fine tubes or fibres, as in muscles and nerves. The function of the capillaries is to subdivide the blood, and act as filters (Notes from Lectures on Institutes).

Veins—These vessels are also termed vessels, they being the channels through which the blood is returned to the heart, after having been transmitted by the arteries over all parts of the body. The veins are the continuation of the capillaries.
they proceed onwards in the direction of the heart, unite together and form larger branches, which again and again anastomose until ultimately they terminate in the large trunks, which pour the blood into the right auricle of the heart. In this way, following a course contrary to that pursued by the arteries.

Structure of Veins. — The veins have much thinner coats than the arteries, although they bear a general resemblance to them, as regards the structure of their coats. All veins are not perfectly alike in structure, yet in those of a medium size, three coats may be distinguished, which as in the arteries have been named, external, middle, internal.

The external coat is composed of fibres interlacing in all directions, and analogous in their nature to those of the cellular and fibrous tissue. The middle coat consists of two or more layers of fibres, which agree in all respects with the white filaments of the cellular tissue, being either
quite pure, or mixed in one or other of the layers with a greater or less amount of fibres, resembling those of the middle coat of the arteries, that is, having the anatomical characters of the plain muscular fibres. — The internal coat closely resembles that of the arteries, but is much less brittle.

Most of the veins differ from the arteries in possessing valves, a mechanical contrivance beautifully adapted to prevent the reflux of the blood. — The general construction of these valves is similar to that of the semi-lunar valves of the aorta & pulmonary artery already described, but their free margins are turned in the opposite direction, that is, towards the heart, so as to stop any movement of blood backwards in the veins. — They are commonly placed in pairs at various distances in different veins, but almost uniformly in each. — In some of the veins, single valves are only met with, whilst in other instances, they exceed the usual number.
While the blood is flowing onwards in its course they lie by the sides of the veins, but when in action they close together like those of the arteries, and form a complete barrier to any backward movement of the blood.

Having now considered the structure and functions of those channels through which the blood is transmitted — it will be necessary for me, before concluding this subject, which I am endeavouring to describe, to advert briefly, in a few words to the blood, its composition, the changes to which it is subjected in its passage through the body. And first with regard to the Blood. The blood is a fluid, which is always kept in constant motion through the vessels already described, and among the various tissues and organs of the body; it is the source whence those tissues and organs draw their nutriment, and from which the glands derive the materials for their several secretions. As seen flowing
in the vessels of a living part, it appears a colourless fluid, containing minute particles, which are named blood corpuscles; while the fluid is termed, Liger sanguinis. When blood is drawn from an artery, it is a thicker fluid, of a red colour; from a vein, it is of a deep purple or nearly black color.

Gr. acc. to Linnon 1041-1082 - Average Gr. generally 1055. And according to Hesse, the extremes consistent with health are 1050-1089.

Its temperature ranges from 90°-100°. It has a slight alkaline reaction, and a peculiar heavy odour. The difference in colour between the arterial and venous blood, are sometimes not discernible. According to Dr. Davy, the arterial is hardly distinguishable from the venous blood in tropical climates, also in cases of Alphysmia.

In all these cases however the dark blood becomes bright on exposure to the air.

The phenomenon of coagulation should just be a waste of time, for one to enter upon the
consideration of this subject; it will be quite sufficient for one to state, that the only coagulable element in the blood is the fibrine; that the coagulation of the blood may be retarded, prevented, or accelerated by the addition, or under the influence of certain substances—thus it may be retarded or prevented by the addition of Alkalis, some of their salts, or sulphate of Soda, nitrate of Potass &c— or without the addition of foreign matter as cold— and accelerated by a temperature of 120° F. &c—

Composition of the Blood— The blood is a very complex fluid, as must be expected, if we regard it as containing the materials for the nutrition of all the tissues, as well as for all the secreitions. The quantity of water present forms four-fifths of the blood; then we find the red corpuscles, albumen, fibrine &c— It is generally computed that 100 parts of healthy blood, contain about 210 parts of solid matter, 790 of water.

According to Becquerel & Rodier, the average
Composition of 1000 sets of blood in men, derived from eleven analyses, is the following—Water 77.9
Red corpuscles 141.1 — Albumen 69.4 — Albune 2.2 —
Extractive matter + free salts 6.8 — Fatty matters 1.6.

The principal points of difference existing between the blood of men and that of women, according to them was the following—that in women the proportion of water + albumen was increased, while the red particles were found to be diminished.

Circulation of the Blood — The passage of the blood through the channels appropriated for its distribution through the tissues and organs of the body, is an essential act for the due maintenance and preservation of those tissues to be in a healthy state, and for the right performance of their functions, however different these may be. Although it was generally believed by the ancients, that the blood was in perpetual motion, yet the nature of this motion, or the course which it pursue was al-together unknown. The honour of the great
discovery of the circulation, the greatest that was ever made in anatomy and physiology, is due to our illustrious countryman Harvey; it was first taught by him in 1619.

Course of Circulation in the Adult. — Taking the left ventricle as the starting point for the circulation, we find the blood pursuing the following course. — By its contraction, the blood is driven through the aorta, into every artery of the body, save the pulmonary, and having passed through the capillary system, it enters the venous radicles; from them it passes to the venous trunks, it is at length returned by two great trunks, the superior, inferior vena cava, to the right auricle of the heart. This is called the systemic circulation.

The venous blood brought to the right auricle is expelled by that cavity into the right ventricle, which drives it by the pulmonary artery through the lung to the pulmonary veins, through which it passes to the left auricle, i.e. on to the left ventricle.
This forms the lesser or pulmonic circulation.

Circulation in the uterus. — Here we find a single circulation carried on with a mechanism intended for a double circulation. — How is this accomplished or in other words, how is a single circulation in the later periods of intero-ception conducted, when there is a vascular system for double circulation.

In order that this may be done there is suffi-
-
-
-
-
ed added Umbilical arteries and vein. In the body we find the Ductus venosus which carries the blood directly from the Umbilical vein to the vena cava inferior, In addition to this the Ductus Arteriosus, which arises from the left division of the Pulmonary artery, and passes directly into the aorta; it shrinks up a few days after birth.

Besides this we have to remember, there is a couple of pieces for the Heart. — The principal piece is between the auricles of the heart, viz. the foramen ovale; in the auricle of the right side, we have the ductus, a duplicate of the internal
living between the inferior vena cava and the auriculo-ventricular orifice. - With this apparatus how is it conducted. - Suppose we start from the placenta, it is carried to the body of the fetus, by the umbilical vein, through the ductus venosus principally to the left vena cava, to the right auricle; it then proceeds directly through into the left auricle, from there to the left ventricle, from thence to the arch of the aorta, where it passes chiefly to the head and upper part of the body of the fetus. It is then recollected and brought down by the left vena cava, through that auricle into the right ventricle, from thence through the ductus arteriosus into the aorta to the lower part of the fetus, from which, it is returned by the hypogastric arteries to the placenta. - According to that doctrine we have two streams of blood passing through the right auricle, without mixing to any extent. - The blood from the left vena cava passes along the back part of the right auricle
into the left auricle, through the foramen ovale.

The stream of blood coming from above, is tilted
over the tubercle of Lower, of the eustachian valve
into the right ventricle.

The manner, in which the state of the blood is changed
during fetal existence, after circulation through the
eystem, differs from that which occurs in the
same animal after birth. In taking this into
account, the most important point to be observed
with regard to the fetus, of the same animal after
birth, is, that the former is altogether excluded from
the atmospheric air, consequently, that its lungs
are incompatible to the performance of their approp-
riate function, viz, that of inducing the requisite
change in the state of the blood. As a result
of this, it is quite evident, that nature must have
recourse to some other adequate means, to induce
a change analogous to that which after birth, it
undergoes in the lungs. This is effected by the
mother, through means of the placenta.
The evidence of the placenta serving as the fetal lungs is, that there is a difference of colour between the blood of the umbilical arteries and that of the vein. We know that there is a change in the blood sent to the placenta; because if we arrest the flow of blood through the umbilical vessels the child presents all the symptoms of asphyxia.

Changes in the blood produced by circulation.

The blood as we have already hinted at contains all the constituent elements necessary for the growth and maintenance of the several functions of the different organs and tissues of which the body is composed. The several parts of the body proceed within themselves an inherent power of selecting those elements which are essential for the construction and growth of their tissues, in this way counteracting the loss caused by the heart's wear of the system; as a result of this, the blood is constantly undergoing change in its transit through the body.

Influence of Respiration on the Blood.

The blood which is propelled from the right side of the heart through the pulmonary artery to the lungs, ...
is venous, of a ferruginous colour; in its passage through the lungs, it is converted into a bright scarlet colour, oxygen being absorbed, & carboxylic acid exhaled, this takes place by endo- or exo-motion. — The quantity of oxygen absorbed is greater than that exhaled in combination with carbon, as carboxylic acid. — It is in the proportion of 1174+1000. — The 78th part of the oxygen or the 174 parts is added to hydrogen, forming water, which is exhaled by the lungs. — Three carboxylic acid exists before it enters the lungs. — The manner in which this process takes place, is the following. — The oxygen of the air is carried by the blood to the ultimate elements of the tissues, chemical combination takes place, & carboxylic acid is produced; the carboxylic acid being then transmitted to the lungs in solution in the venous blood, & there exhaled. — The absolute quantity of carbon exhaled from the lungs, is 160 grs per hour, in an adult man. — The amount of water vapour given off is from 6-27 grs per day.
Changes in the blood resulting from respiration.

1. The temperature of the arterial blood is higher than that of venous.

2. The Sp. Gr. of venous is higher than that of arterial, as 1059–1050.

3. In the greater number of analyses there was more fibrin in arterial blood than in venous.

4. The blood corpuscles are greater in the arterial, than in the venous blood; by some, vice versa, by others.

5. Free gases exist in blood. The relative amount of oxygen to carbonic acid is greater in arterial than in venous blood.

6. The shape of the corpuscles are different. Most observers agree that the corpuscles are less clear in venous than in arterial blood.

In the preceding pages, I have endeavored to describe the most important points, in connection with the vascular system, and although I am quite certain of its many imperfections, yet hope, that the many facts which I have
stated with regard to the Anatomy and Physiology of this system, may more than counterbalance the defects, which are to be found in this description.

Robert Wilson