THE VEINS.

The Veins convey the blood from the capillaries of the different parts of the body to the heart. They consist of two distinct sets of vessels, the pulmonary and systemic.

The Pulmonary Veins, unlike other veins, contain arterial blood, which they return from the lungs to the left atrium of the heart.

The Systemic Veins return the venous blood from the body generally to the right atrium of the heart.

The Portal Vein, an appendage to the systemic venous system, is confined to the abdominal cavity, and returns the venous blood from the spleen and the viscera of digestion to the liver. This vessel ramifies in the substance of the liver and there breaks up into a minute network of capillary-like vessels, from which the blood is conveyed by the hepatic veins to the inferior vena cava.

The veins commence by minute plexuses which receive the blood from the capillaries. The branches arising from these plexuses unite together into trunks, and these, in their passage toward the heart, constantly increase in size as they receive tributaries, or join other veins. The veins are larger and altogether more numerous than the arteries; hence, the entire capacity of the venous system is much greater than that of the arterial; the capacity of the pulmonary veins, however, only slightly exceeds that of the pulmonary arteries. The veins are cylindrical like the arteries; their walls, however, are thin and they collapse when the vessels are empty, and the uniformity of their surfaces is interrupted at intervals by slight constrictions, which indicate the existence of valves in their interior. They communicate very freely with one another, especially in certain regions of the body; and these communications exist between the larger trunks as well as between the smaller branches. Thus, between the venous sinuses of the cranium, and between the veins of the neck, where obstruction would be attended with imminent danger to the cerebral venous system, large and frequent anastomoses are found. The same free communication exists between the veins throughout the whole extent of the vertebral canal, and between the veins composing the various venous plexuses in the abdomen and pelvis, e. g., the spermatic, uterine, vesical, and pudendal.

The systemic venous channels are subdivided into three sets, viz., superficial and deep veins, and venous sinuses.

The Superficial Veins (cutaneous veins) are found between the layers of the superficial fascia immediately beneath the skin; they return the blood from these structures, and communicate with the deep veins by perforating the deep fascia.

The Deep Veins accompany the arteries, and are usually enclosed in the same sheaths with those vessels. With the smaller arteries—as the radial, ulnar, brachial, tibial, peroneal—they exist generally in pairs, one lying on each side of the vessel, and are called veins comitantes. The larger arteries—such as the axillary, subclavian, popliteal, and femoral—have usually only one accompanying vein. In certain organs of the body, however, the deep veins do not accompany the arteries; for instance, the veins in the skull and vertebral canal, the hepatic veins in the liver, and the larger veins returning blood from the bones.

Venous Sinuses are found only in the interior of the skull, and consist of canals formed by a separation of the two layers of the dura mater; their outer coat consists of fibrous tissue, their inner of an endothelial layer continuous with the lining membrane of the veins.
THE PULMONARY VEINS (VENA PULMONALES).

The **pulmonary veins** return the arterialized blood from the lungs to the left atrium of the heart. They are four in number, two from each lung, and are destitute of valves. The commence in a capillary net-work upon the walls of the air sacs, where they are continuous with the capillary ramifications of the pulmonary artery, and, joining together, form one vessel for each lobe. These vessels uniting successively, form a single trunk for each lobe, three for the right, and two for the left lung. The vein from the middle lobe of the right lung generally unites with that from the upper lobe, so that ultimately two trunks from each lung are formed; they perforate the fibrous layer of the pericardium and open separately into the upper and back part of the left atrium. Occasionally the three veins on the right side remain separate. Not infrequently the two left pulmonary veins end by a common opening.

*At the root of the lung*, the superior pulmonary vein lies in front of and a little below the pulmonary artery; the inferior is situated at the lowest part of the hilus of the lung and on a plane posterior to the upper vein. *Behind the pulmonary artery is the bronchus.*

*Within the pericardium*, their anterior surfaces are invested by the serous layer of this membrane.

The right pulmonary veins pass behind the right atrium and superior vena cava; the left in front of the descending thoracic aorta.

THE SYSTEMIC VEINS.

The **systemic veins** may be arranged into three groups: (1) The veins of the heart. (2) The veins of the **upper extremities, head, neck, and thorax**, which end in the superior vena cava. (3) The veins of the **lower extremities, abdomen, and pelvis**, which end in the inferior vena cava.

THE VEINS OF THE HEART (Vv. Cordis) (Fig. 556).

**Coronary Sinus** (*sinus coronarius*).—Most of the veins of the heart open into the coronary sinus. This is a wide venous channel about 2.25 cm. in length situated in the posterior part of the coronary sulcus, and covered by muscular fibers from the left atrium. It ends in the right atrium between the opening of the inferior vena cava and the atrioventricular aperture, its orifice being guarded by a semilunar valve, the **valve of the coronary sinus** (*valve of Thebesius*).

**Tributaries.**—Its tributaries are the great, small, and middle cardiac veins, the posterior vein of the left ventricle, and the oblique vein of the left atrium, all of which, except the last, are provided with valves at their orifices.

1. The **Great Cardiac Vein** (*v. cordis magna; left coronary vein*) begins at the apex of the heart and ascends along the anterior longitudinal sulcus to the base of the ventricles. It then curves to the left in the coronary sulcus, and reaching the back of the heart, opens into the left extremity of the coronary sinus. It receives tributaries from the left atrium and from both ventricles: one, the **left marginal vein**, is of considerable size, and ascends along the left margin of the heart.

2. The **Small Cardiac Vein** (*v. cordis parva; right coronary vein*) runs in the coronary sulcus between the right atrium and ventricle, and opens into the right extremity of the coronary sinus. It receives blood from the back of the right atrium and ventricle; the **right marginal vein** ascends along the right margin of the heart and joins it in the coronary sulcus, or opens directly into the right atrium.
3. The Middle Cardiac Vein (v. cordis media) commences at the apex of the heart, ascends in the posterior longitudinal sulcus, and ends in the coronary sinus near its right extremity.

4. The Posterior Vein of the Left Ventricle (v. posterior ventriculi sinistri) runs on the diaphragmatic surface of the left ventricle to the coronary sinus, but may end in the great cardiac vein.

5. The Oblique Vein of the Left Atrium (v. obliqua atrii sinistri [Marshalli]; oblique vein of Marshall) is a small vessel which descends obliquely on the back of the left atrium and ends in the coronary sinus near its left extremity; it is continuous above with the ligament of the left vena cava (lig. vena cava sinistrum; vestigial fold of Marshall), and the two structures form the remnant of the left Cuvierian duct.

The following cardiac veins do not end in the coronary sinus: (1) the anterior cardiac veins, comprising three or four small vessels which collect blood from the front of the right ventricle and open into the right atrium; the right marginal vein frequently opens into the right atrium, and is therefore sometimes regarded as belonging to this group; (2) the smallest cardiac veins (veins of Thebesius), consisting of a number of minute veins which arise in the muscular wall of the heart; the majority open into the atria, but a few end in the ventricles.

THE VEINS OF THE HEAD AND NECK.

The veins of the head and neck may be subdivided into three groups: (1) The veins of the exterior of the head and face. (2) The veins of the neck. (3) The diploic veins, the veins of the brain, and the venous sinuses of the dura mater.
The Veins of the Exterior of the Head and Face (Fig. 557).

The veins of the exterior of the head and face are:

- Frontal.
- Supraorbital.
- Angular.
- Anterior Facial.
- Superficial Temporal
- Internal Maxillary.
- Posterior Facial.
- Posterior Auricular.
- Occipital.

The **frontal vein** (c. frontalis) begins on the forehead in a venous plexus which communicates with the frontal branches of the superficial temporal vein. The veins converge to form a single trunk, which runs downward near the middle line of the forehead parallel with the vein of the opposite side. The two veins are joined, at the root of the nose, by a transverse branch, called the **nasal arch**, which receives some small veins from the dorsum of the nose. At the root of the nose the veins diverge, and, each at the medial angle of the orbit, joins the **supraorbital vein**, to
form the angular vein. Occasionally the frontal veins join to form a single trunk, which bifurcates at the root of the nose into the two angular veins.

The supraorbital vein (e. supraorbitalis) begins on the forehead where it communicates with the frontal branch of the superficial temporal vein. It runs downward superficial to the Frontalis muscle, and joins the frontal vein at the medial angle of the orbit to form the angular vein. Previous to its junction with the frontal vein, it sends through the supraorbital notch into the orbit a branch which communicates with the ophthalmic vein; as this vessel passes through the notch, it receives the frontal diploic vein through a foramen at the bottom of the notch.

The angular vein (e. angularis) formed by the junction of the frontal and supraorbital veins, runs obliquely downward, on the side of the root of the nose, to the level of the lower margin of the orbit, where it becomes the anterior facial vein. It receives the veins of the ala nasi, and communicates with the superior ophthalmic vein through the nasofrontal vein, thus establishing an important anastomosis between the anterior facial vein and the cavernous sinus.

The anterior facial vein (e. facialis anterior; facial vein) commences at the side of the root of the nose, and is a direct continuation of the angular vein. It lies behind the external maxillary (facial) artery and follows a less tortuous course. It runs obliquely downward and backward, beneath the Zygomaticus and zygomatic head of the Quadratus labii superioris, descends along the anterior border and then on the superficial surface of the Masseter, crosses over the body of the mandible, and passes obliquely backward, beneath the Platysma and cervical fascia, superficial to the submaxillary gland, the Digastricus and Stylohyoideus. It unites with the posterior facial vein to form the common facial vein, which crosses the external carotid artery and enters the internal jugular vein at a variable point below the hyoid bone. From near its termination a communicating branch often runs down the anterior border of the Sternoclidomastoideus to join the lower part of the anterior jugular vein. The facial vein has no valves, and its walls are not so flaccid as most superficial veins.

Tributaries.—The anterior facial vein receives a branch of considerable size, the deep facial vein, from the pterygoid venous plexus. It is also joined by the superior and inferior palpebral, the superior and inferior labial, the buccinator and the masseteric veins. Below the mandible it receives the submental, palatine, and submaxillary veins, and, generally, the vena comitans of the hypoglossal nerve.

The superficial temporal vein (e. temporalis superficialis) begins on the side and vertex of the skull in a plexus which communicates with the frontal and supraorbital veins, with the corresponding vein of the opposite side, and with the posterior auricular and occipital veins. From this net-work frontal and parietal branches arise, and unite above the zygomatic arch to form the trunk of the vein, which is joined in this situation by the middle temporal vein, from the substance of the Temporalis. It then crosses the posterior root of the zygomatic arch, enters the substance of the parotid gland, and unites with the internal maxillary vein to form the posterior facial vein.

Tributaries.—The superficial temporal vein receives in its course some parotid veins, articular veins from the temporomandibular joint, anterior auricular veins from the auricula, and the transverse facial from the side of the face. The middle temporal vein receives the orbital vein, which is formed by some lateral palpebral branches, and passes backward between the layers of the temporal fascia to join the superficial temporal vein.

The pterygoid plexus (plexus pterygoideus) is of considerable size, and is situated between the Temporalis and Pterygoideus externus, and partly between the two Pterygoidei. It receives tributaries corresponding with the branches of the internal maxillary artery. Thus it receives the sphenopalatine, the middle meningeal, the deep temporal, the pterygoid, masseteric, buccinator, alveolar, and some palatine
veins, and a branch which communicates with the ophthalmic vein through the inferior orbital fissure. This plexus communicates freely with the anterior facial vein; it also communicates with the cavernous sinus, by branches through the foramen Vesali, foramen ovale, and foramen lacerum.

The internal maxillary vein (v. maxillaris internus) is a short trunk which accompanies the first part of the internal maxillary artery. It is formed by a confluence of the veins of the pterygoid plexus, and passes backward between the sphenomandibular ligament and the neck of the mandible, and unites with the temporal vein to form the posterior facial vein.

The posterior facial vein (v. facialis posterior; temporomaxillary vein), formed by the union of the superficial temporal and internal maxillary veins, descends in the substance of the parotid gland, superficial to the external carotid artery but beneath the facial nerve, between the ramus of the mandible and the Sternocleidomastoideus muscle. It divides into two branches, an anterior, which passes forward and unites with the anterior facial vein to form the common facial vein and a posterior, which is joined by the posterior auricular vein and becomes the external jugular vein.

The posterior auricular vein (v. auricularis posterior) begins upon the side of the head, in a plexus which communicates with the tributaries of the occipital, and superficial temporal veins. It descends behind the auricula, and joins the posterior division of the posterior facial vein to form the external jugular. It receive the stylomastoid vein, and some tributaries from the cranial surface of the auricula.

The occipital vein (v. occipitalis) begins in a plexus at the back part of the vertex of the skull. From the plexus emerges a single vessel, which pierces the cranial attachment of the Trapezius and, dipping into the suboccipital triangle, joins the deep cervical and vertebral veins. Occasionally it follows the course of the occipital artery and ends in the internal jugular; in other instances, it joins the posterior auricular and through it opens into the external jugular. The parietal emissary vein connects it with the superior sagittal sinus; and as it passes across the mastoid portion of the temporal bone, it receives the mastoid emissary vein which connects it with the transverse sinus. The occipital diploic vein sometimes joins it.

The Veins of the Neck (Fig. 538).

The veins of the neck, which return the blood from the head and face, are:

- External Jugular.
- Anterior Jugular.
- Posterior External Jugular.
- Internal Jugular.
- Vertebral.

The external jugular vein (v. jugularis externa) receives the greater part of the blood from the exterior of the cranium and the deep parts of the face, being formed by the junction of the posterior division of the posterior facial with the posterior auricular vein. It commences in the substance of the parotid gland, on a level with the angle of the mandible, and runs perpendicularly down the neck, in the direction of a line drawn from the angle of the mandible to the middle of the clavicle at the posterior border of the Sternocleidomastoideus. In its course it crosses the Sternocleidomastoideus obliquely, and in the subclavian triangle perforates the deep fascia, and ends in the subclavian vein, lateral to or in front of the SCalenus anterior. It is separated from the Sternocleidomastoideus by the investing layer of the deep cervical fascia, and is covered by the Platysma, the superficial fascia, and the integument; it crosses the cutaneous cervical nerve, and its upper half runs parallel with the great auricular nerve. The external jugular vein varies in size, bearing an inverse proportion to the other veins of the neck, it is occasionally
double. It is provided with two pairs of valves, the lower pair being placed at its entrance into the subclavian vein, the upper in most cases about 4 cm. above the clavicle. The portion of vein between the two sets of valves is often dilated, and is termed the sinus. These valves do not prevent the regurgitation of the blood, or the passage of injection from below upward.

Tributaries.—This vein receives the occipital occasionally, the posterior external jugular, and, near its termination, the transverse cervical, transverse scapular, and anterior jugular veins; in the substance of the parotid, a large branch of communication from the internal jugular joins it.

The posterior external jugular vein (v. jugularis posterior) begins in the occipital region and returns the blood from the skin and superficial muscles in the upper and back part of the neck, lying between the Splenius and Trapezius. It runs down the back part of the neck, and opens into the external jugular vein just below the middle of its course.

The anterior jugular vein (v. jugularis anterior) begins near the hyoid bone by the confluence of several superficial veins from the submaxillary region. It descends between the median line and the anterior border of the Sternocleidomastoideus, and, at the lower part of the neck, passes beneath that muscle to open into the termination of the external jugular, or, in some instances, into the subclavian vein (Figs. 557, 558). It varies considerably in size, bearing usually an inverse propor-
tion to the external jugular; most frequently there are two anterior jugulars, a right and left; but sometimes only one. Its tributaries are some laryngeal veins, and occasionally a small thyroid vein. Just above the sternum the two anterior jugular veins communicate by a transverse trunk, the venous jugular arch, which receive tributaries from the inferior thyroid veins; each also communicates with the internal jugular. There are no valves in this vein.

The **internal jugular vein** (v. jugularis interna) collects the blood from the brain, from the superficial parts of the face, and from the neck. It is directly continuous with the transverse sinus, and begins in the posterior compartment of the jugular foramen, at the base of the skull. At its origin it is somewhat dilated, and this dilatation is called the **superior bulb**. It runs down the side of the neck in a vertical direction, lying at first lateral to the internal carotid artery, and then lateral to the common carotid, and at the root of the neck unites with the subclavian vein to form the innominate vein; a little above its termination is a second dilatation, the **inferior bulb**. Above, it lies upon the Rectus capitis lateralis, behind the internal carotid artery and the nerves passing through the jugular foramen; lower down, the vein and artery lie upon the same plane, the glossoopharyngeal and hypoglossal nerves passing forward between them; the vagus descends between and behind the vein and the artery in the same sheath, and the accessory runs obliquely backward, superficial or deep to the vein. At the root of the neck the right internal jugular vein is placed at a little distance from the common carotid artery, and crosses the first part of the subclavian artery, while the left internal jugular vein usually overlaps the common carotid artery. The left vein is generally smaller than the right, and each contains a pair of valves, which are placed about 2.5 cm. above the termination of the vessel.

**Tributaries.**—This vein receives in its course the **inferior petrosal sinus**, the common facial, lingual, pharyngeal, superior and middle thyroid veins, and sometimes the occipital. The thoracic duct on the left side and the right lymphatic duct on the right side open into the angle of union of the internal jugular and subclavian veins.

The **inferior petrosal sinus** (sinus petrosus inferior) leaves the skull through the anterior part of the jugular foramen, and joins the superior bulb of the internal jugular vein.

The **lingual veins** (ve. linguales) begin on the dorsum, sides, and under surface of the tongue, and, passing backward along the course of the lingual artery, end in the internal jugular vein. The vena comitans of the hypoglossal nerve (**ramus**
vein), a branch of considerable size, begins below the tip of the tongue, and may join the lingual; generally, however, it passes backward on the Hyoglossus, and joins the common facial.

The Pharyngeal Veins (m. pharyngae) begin in the pharyngeal plexus on the outer surface of the pharynx, and, after receiving some posterior meningeal veins and the vein of the pterygoid canal, end in the internal jugular. They occasionally open into the facial, lingual, or superior thyroid vein.

The Superior Thyroid Vein (v. thyreoidea superioris) (Fig. 560) begins in the substance and on the surface of the thyroid gland, by tributaries corresponding with the branches of the superior thyroid artery, and ends in the upper part of the internal jugular vein. It receives the superior laryngeal and e ricothyroid veins.

The Middle Thyroid Vein (Figs. 561, 562) collects the blood from the lower part of the thyroid gland, and after being joined by some veins from the larynx and trachea, ends in the lower part of the internal jugular vein.

The common facial and occipital veins have been described.

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The vertebral vein (v. vertebralis) is formed in the suboccipital triangle, from numerous small tributaries which spring from the internal vertebral venous plexuses and issue from the vertebral canal above the posterior arch of the atlas. They unite with small veins from the deep muscles at the upper part of the back of the neck, and form a vessel which enters the foramen in the transverse process of the atlas, and descends, forming a dense plexus around the vertebral artery, in the canal formed by the foramina transversaria of the cervical vertebrae. This plexus ends in a single trunk, which emerges from the foramen transversarium of the sixth cervical vertebra, and opens at the root of the neck into the back part of the innominate vein near its origin, its mouth being guarded by a pair of valves. On the right side, it crosses the first part of the subclavian artery.
Tributaries.—The vertebral vein communicates with the transverse sinus by a vein which passes through the condyloid canal, when that canal exists. It receives branches from the occipital vein and from the prevertebral muscles, from the internal and external vertebral venous plexuses, from the anterior vertebral...
Cervical veins; close to its termination it is sometimes joined by the vertebral vein.

Superior Vertebral Vein commences in a plexus around the transverse processes of the upper cervical vertebrae, descends in company with the ascending cervical artery between the Sphenius anterior and Longus capitis muscles, and the terminal part of the vertebral vein.

**Superior Vertebral Vein (v. vertebralis profunda; posterior vertebral or posterior deep cervical vein) accompanies its artery between the Semispinales capitis and erector spinae in the suboccipital region by communicating branches from the internal and by small veins from the deep muscles at the back of the neck. Its tributaries from the plexuses around the spinous processes of the vertebrae, and terminates in the lower part of the vertebral vein.**

The Diploic Veins (Vena Diploicae) (Fig. 564).

Diploic veins occupy channels in the diploe of the cranial bones. They are exhibited at irregular intervals pouch-like dilatations; their walls are thin, lined with endothelium resting upon a layer of elastic tissue. As the cranial bones are separable from one another, these veins are separate; but when the sutures are obliterated, they unite with each other, and increase in size. They communicate with the meningeal sinuses of the dura mater, and with the veins of the pericranium. They are of (1) the frontal, which opens into the supraorbital vein and the gittal sinus; (2) the anterior temporal, which is confined chiefly to the face, and opens into the sphenoparietal sinus and into one of the deep veins, through an aperture in the great wing of the sphenoid; (3) the posterior, which is situated in the parietal bone, and ends in the transverse sinus through an aperture at the mastoid angle of the parietal bone or through the
mastoid foramen; and (4) the occipital, the largest of the four, which is confined to the occipital bone, and opens either externally into the occipital vein, or internally into the transverse sinus or into the confluence of the sinuses (torcular Herophili).

The Veins of the Brain.

The veins of the brain possess no valves, and their walls, owing to the absence of muscular tissue, are extremely thin. They pierce the arachnoid membrane and the inner or meningeal layer of the dura mater, and open into the cranial venous sinuses. They may be divided into two sets, cerebral and cerebellar.

The cerebral veins (ve. cerebri) are divisible into external and internal groups according as they drain the outer surfaces or the inner parts of the hemispheres.

The external veins are the superior, inferior, and middle cerebral.

The Superior Cerebral Veins (ve. cerebri superiores), eight to twelve in number, drain the superior, lateral, and medial surfaces of the hemispheres, and are mainly lodged in the sulci between the gyri, but some run across the gyri. They open into the superior sagittal sinus; the anterior veins run nearly at right angles to the sinus; the posterior and larger veins are directed obliquely forward and open into the sinus in a direction more or less opposed to the current of the blood contained within it.

The Middle Cerebral Vein (ve. cerebri media; superficial Sylvian vein) begins on the lateral surface of the hemisphere, and, running along the lateral cerebral fissure, ends in the cavernous or the sphenoparietal sinus. It is connected (a) with the superior sagittal sinus by the great anastomotic vein of Trolard, which opens into one of the superior cerebral veins; (b) with the transverse sinus by the posterior anastomotic vein of Labbé, which courses over the temporal lobe.

The Inferior Cerebral Veins (ve. cerebri inferiores), of small size, drain the under surfaces of the hemispheres. Those on the orbital surface of the frontal lobe join the superior cerebral veins, and through these open into the superior sagittal sinus; those of the temporal lobe anastomose with the middle cerebral and basal veins, and join the cavernous, sphenoparietal, and superior petrosal sinuses.
The **basal vein** is formed at the anterior perforated substance by the union of (a) a small **anterior cerebral vein** which accompanies the anterior cerebral artery, (b) the **deep middle cerebral vein** (deep Sylvian vein), which receives tributaries from the insula and neighboring gyri, and runs in the lower part of the lateral cerebral fissure, and (c) the **inferior striate veins**, which leave the corpus striatum through the anterior perforated substance. The basal vein passes backward around the cerebral peduncle, and ends in the internal cerebral vein (vein of Galen); it receives tributaries from the interpeduncular fossa, the inferior horn of the lateral ventricle, the hippocampal gyrus, and the mid-brain.

The **Internal Cerebral Veins** (ve. cerebri interna; veins of Galen; deep cerebral veins) drain the deep parts of the hemisphere and are two in number; each is formed near the interventricular foramen by the union of the **terminal** and **choroid veins**. They run backward parallel with one another, between the layers of the tela chorioidea of the third ventricle, and beneath the splenium of the corpus callosum, where they unite to form a short trunk, the **great cerebral vein**; just before their union each receives the corresponding basal vein.

The **terminal vein** (ve. terminalis; venae corporis striati) commences in the groove between the corpus striatum and thalamus, receives numerous veins from both of these parts, and unites behind the crus fornix with the choroid vein, to form one of the internal cerebral veins. The **choroid vein** runs along the whole length of the choroid plexus, and receives veins from the hippocampus, the fornix, and the corpus callosum.

![Diagram of the brain](Fig. 565.—Veum interponetum. (Poirier and Charpy.)

The **Great Cerebral Vein** (v. cerebri magna [Galen]; great vein of Galen) (Fig. 565), formed by the union of the two internal cerebral veins, is a short median trunk which curves backward and upward around the splenium of the corpus callosum and ends in the anterior extremity of the straight sinus.

The **cerebellar veins** are placed on the surface of the cerebellum, and are disposed in two sets, superior and inferior. The **superior cerebellar veins** (ve. cerebelli superiores) pass partly forward and mediallyward, across the superior vermis, to end in the straight sinus and the internal cerebral veins, partly laterallyward to the transverse and superior petrosal sinuses. The **inferior cerebellar veins** (ve. cerebelli inferiores) of large size, end in the transverse, superior petrosal, and occipital sinuses.
The Sinuses of the Dura Mater (Sinus Duroe Matris). Ophthalmic Veins and Emissary Veins.

The sinuses of the dura mater are venous channels which drain the blood from the brain; they are devoid of valves, and are situated between the two layers of the dura mater and lined by endothelium continuous with that which lines the veins. They may be divided into two groups: (1) a postero-superior, at the upper and back part of the skull, and (2) an antero-inferior, at the base of the skull.

The postero-superior group comprises the

- Superior Sagittal
- Inferior Sagittal
- Occipital
- Straight
- Two Transverse

The superior sagittal sinus (sinus sagittalis superior; superior longitudinal sinus) (Figs. 566, 567) occupies the attached or convex margin of the falx cerebri. Commencing at the foramen cecum, through which it receives a vein from the nasal cavity, it runs from before backward, grooving the inner surface of the frontal. the adjacent margins of the two parietals, and the superior division of the cruciate eminence of the occipital; near the internal occipital protuberance it deviates to one or other side (usually the right), and is continued as the corresponding transverse sinus. It is triangular in section, narrow in front, and gradually increases in size as it passes backward. Its inner surface presents the openings of the superior cerebral veins, which run, for the most part, obliquely forward, and open chiefly at the back part of the sinus, their orifices being concealed by fibrous folds; numerous
fibrous bands (chorda Willisi) extend transversely across the inferior angle of the sinus; and, lastly, small openings communicate with irregularly shaped venous spaces (venous lacunae) in the dura mater near the sinus. There are usually three lacunae on either side of the sinus: a small frontal, a large parietal, and an occipital, intermediate in size between the other two (Sargent). Most of the cerebral veins from the outer surface of the hemisphere open into these lacunae, and numerous arachnoid granulations (Pouchetian bodies) project into them from below.

The superior sagittal sinus receives the superior cerebral veins, veins from the diploe and dura mater, and, near the posterior extremity of the sagittal suture, veins from the pericranium, which pass through the parietal foramina.

The numerous communications exist between this sinus and the veins of the nose, scalp, and diploe.

The inferior sagittal sinus (sinus sagittalis inferior; inferior longitudinal sinus) (Fig. 567) is contained in the posterior half or two-thirds of the free margin of the falx cerebri. It is of a cylindrical form, increases in size as it passes backward, and ends in the straight sinus. It receives several veins from the falx cerebri, and occasionally a few from the medial surfaces of the hemispheres.

The straight sinus (sinus rectus; tentorial sinus) (Figs. 567, 569) is situated at the line of junction of the falx cerebri with the tentorium cerebelli. It is triangular

in section, increases in size as it proceeds backward, and runs downward and backward from the end of the inferior sagittal sinus to the transverse sinus of the opposite side to that into which the superior sagittal sinus is prolonged. Its terminal part communicates by a cross branch with the confluence of the sinuses. Besides
the inferior sagittal sinus, it receives the great cerebral vein (great vein of Galen) and the superior cerebellar veins. A few transverse bands cross its interior.

The transverse sinuses (sinus transversus; lateral sinuses) (Figs. 569, 570) are of large size and begin at the internal occipital protuberance; one, generally the right, being the direct continuation of the superior sagittal sinus, the other of the straight sinus. Each transverse sinus passes laterally and forward, describing a slight curve with its convexity upward, to the base of the petrous portion of the temporal bone, and lies, in this part of its course, in the attached margin of the tentorium cerebelli; it then leaves the tentorium and curves downward and

![Superior sagittal sinus](image)

**Fig. 570.—The sinuses at the base of the skull.**

medialward to reach the jugular foramen, where it ends in the internal jugular vein. In its course it rests upon the squama of the occipital, the mastoid angle of the parietal, the mastoid part of the temporal, and, just before its termination, the jugular process of the occipital; the portion which occupies the groove on the mastoid part of the temporal is sometimes termed the sigmoid sinus. The transverse sinuses are frequently of unequal size, that formed by the superior sagittal sinus being the larger; they increase in size as they proceed from behind forward. On transverse section the horizontal portion exhibits a prismatic, the curved portion a semicylindrical form. They receive the blood from the superior petrosal
sinuses at the base of the petrous portion of the temporal bone; they communicate with the veins of the pericranium by means of the mastoid and condyloid emissary veins; and they receive some of the inferior cerebral and inferior cerebellar veins, and some veins from the diploë. The petrosquamous sinus, when present, runs backward along the junction of the squama and petrous portion of the temporal, and opens into the transverse sinus.

The occipital sinus (sinus occipitalis) (Fig. 570) is the smallest of the cranial sinuses. It is situated in the attached margin of the falx cerebelli, and is generally single, but occasionally there are two. It commences around the margin of the foramen magnum by several small venous channels, one of which joins the terminal part of the transverse sinus; it communicates with the posterior internal vertebral venous plexuses and ends in the confluence of the sinuses.

The Confluence of the Sinuses (confluentes sinusum; torcular Herophili) is the term applied to the dilated extremity of the superior sagittal sinus. It is of irregular form, and is lodged on one side (generally the right) of the internal occipital protuberance. From it the transverse sinus of the same side is derived. It receives also the blood from the occipital sinus, and is connected across the middle line with the commencement of the transverse sinus of the opposite side.

The antero-inferior group of sinuses comprises the

Two Cavernous.
Two Intercavernous

Two Superior Petrosal.
Two Inferior Petrosal.
Basilar Plexus.

The cavernous sinuses (sinus cavernosus) (Figs. 570, 571) are so named because they present a reticulated structure, due to their being traversed by numerous interlacing filaments. They are of irregular form, larger behind than in front, and are placed one on either side of the body of the sphenoid bone, extending from the superior orbital fissure to the apex of the petrous portion of the temporal bone. Each opens behind into the petrosal sinuses. On the medial wall of each sinus is the internal carotid artery, accompanied by filaments of the carotid plexus; near the artery is the abducent nerve: on the lateral wall are the oculomotor and trochlear nerves, and the ophthalmic and maxillary divisions of the trigeminal nerve (Fig. 571). These structures are separated from the blood flowing along the sinus by the lining membrane of the sinus. The cavernous sinus receives the superior ophthalmic vein through the superior orbital fissure, some of the cerebral veins, and also the small sphenoparietal sinus, which courses along the under surface of the small wing of the sphenoid. It communicates with the transverse sinus by means of the superior petrosal sinus; with the internal jugular vein through the inferior petrosal sinus and a plexus of veins on the internal carotid artery; with the pterygoid venous plexus through the foramen Vesali, foramen ovale, and foramen lacerum, and with the angular vein through the ophthalmic vein. The two sinuses also communicate with each other by means of the anterior and posterior intercavernous sinuses.

The ophthalmic veins (Fig. 572), two in number, superior and inferior, are devoid of valves.
The Superior Ophthalmic Vein (s. ophthalmica superior) begins at the inner angle of the orbit by a vein named the nasofrontal which communicates anteriorly with the angular vein; it pursues the same course as the ophthalmic artery, and receives tributaries corresponding to the branches of that vessel. Forming a short single trunk, it passes between the two heads of the Rectus lateralis and through the medial part of the superior orbital fissure, and ends in the cavernous sinus.

The Inferior Ophthalmic Vein (s. ophthalmica inferior) begins in a venous net-work at the forepart of the floor and medial wall of the orbit; it receives some veins from the Rectus inferior, Obliquus inferior, lacrimal sac and eyelids, runs backward in the lower part of the orbit and divides into two branches. One of these passes through the inferior orbital fissure and joins the pterygoid venous plexus, while the other enters the cranium through the superior orbital fissure and ends in the cavernous sinus, either by a separate opening, or more frequently in common with the superior ophthalmic vein.

![Figure 572: Veins of orbit](Poirier and Charpy)

The intercavernous sinuses (sini intercavernosi) (Fig. 570) are two in number, an anterior and a posterior, and connect the two cavernous sinuses across the middle line. The anterior passes in front of the hypophysis cerebri, the posterior behind it, and they form with the cavernous sinuses a venous circle (circular sinus) around the hypophysis. The anterior one is usually the larger of the two, and one or other is occasionally absent.

The superior petrosal sinus (s. petrosus superior) (Fig. 570) small and narrow, connects the cavernous with the transverse sinus. It runs lateralward and backward, from the posterior end of the cavernous sinus, over the trigeminal nerve, and lies in the attached margin of the tentorium cerebelli and in the superior petrosal sulcus of the temporal bone; it joins the transverse sinus where the latter curves downward on the inner surface of the mastoid part of the temporal. It receives some cerebellar and inferior cerebral veins, and veins from the tympanic cavity.

The inferior petrosal sinus (s. petrosus inferior) (Fig. 570) is situated in the inferior petrosal sulcus formed by the junction of the petrous part of the temporal with the basilar part of the occipital. It begins in the postero-inferior part of the cavernous sinus, and, passing through the anterior part of the jugular foramen, ends in the superior bulb of the internal jugular vein. The inferior petrosal sinus
receives the internal auditory veins and also veins from the medulla oblongata, pons, and under surface of the cerebellum.

The exact relation of the parts to one another in the jugular foramen is as follows: the inferior petrosal sinus lies medially and anteriorly with the meningeal branch of the ascending pharyngeal artery, and is directed obliquely downward and backward; the transverse sinus is situated at the lateral and back part of the foramen with a meningeal branch of the occipital bone, and between the two sinuses are the glossopharyngeal, vagus, and accessory nerves. These three sets of structures are divided from each other by two processes of fibrous tissue. The junction of the inferior petrosal sinus with the internal jugular vein takes place on the lateral aspect of the nerves.

The basilar plexus (plexus basilaris; transverse or basilar sinus) (Fig. 571) consists of several interlacing venous channels between the layers of the dura mater over the basilar part of the occipital bone, and serves to connect the two inferior petrosal sinuses. It communicates with the anterior vertebral venous plexus.

Emissary Veins (emissaria).—The emissary veins pass through apertures in the cranial wall and establish communication between the sinuses inside the skull and the veins external to it. Some are always present, others only occasionally so. The principal emissary veins are the following: (1) A mastoid emissary vein, usually present, runs through the mastoid foramen and unites the transverse sinus with the posterior auricular or with the occipital vein. (2) A parietal emissary vein passes through the parietal foramen and connects the superior sagittal sinus with the veins of the scalp. (3) A net-work of minute veins (rete canalis hypoglossi) traverses the hypoglossal canal and joins the transverse sinus with the vertebral vein and deep veins of the neck. (4) An inconstant condylar emissary vein passes through the condylar canal and connects the transverse sinus with the deep veins of the neck. (5) A net-work of veins (rete foraminis orbitis) unites the cavernous sinus with the pterygoid plexus through the foramen ovale. (6) Two or three small veins run through the foramen lacerum and connect the cavernous sinus with the pterygoid plexus. (7) The emissary vein of the foramen of Vesalius connects the same parts. (8) An internal carotid plexus of veins traverses the carotid canal and unites the cavernous sinus with the internal jugular vein. (9) A vein is transmitted through the foramen cecum and connects the superior sagittal sinus with the veins of the nasal cavity.

THE VEINS OF THE UPPER EXTREMITY AND THORAX.

The veins of the upper extremity are divided into two sets, superficial and deep; the two sets anastomose frequently with each other. The superficial veins are placed immediately beneath the integument between the two layers of superficial fascia. The deep veins accompany the arteries, and constitute the venous companions of those vessels. Both sets are provided with valves, which are more numerous in the deep than in the superficial veins.

The Superficial Veins of the Upper Extremity.

The superficial veins of the upper extremity are the digital, metacarpal, cephalic, basilic, median.

Digital Veins.—The dorsal digital veins pass along the sides of the fingers and are joined to one another by oblique communicating branches. Those from the adjacent sides of the fingers unite to form three dorsal metacarpal veins (Fig. 573), which end in a dorsal venous net-work opposite the middle of the metacarpus. The radial part of the net-work is joined by the dorsal digital vein from the radial side of the index finger and the dorsal digital veins of the thumb, and is prolonged upward as the cephalic vein. The ulnar part of the net-work receives
the dorsal digital vein of the ulnar side of the little finger and is continued upward as the basilic vein. A communicating branch frequently connects the dorsal venous network with the cephalic vein about the middle of the forearm.

The volar digital veins on each finger are connected to the dorsal digital veins by oblique intercapitular veins. They drain into a venous plexus which is situated over the thenar and hypothenar eminences and across the front of the wrist.

The cephalic vein (Fig. 574) begins in the radial part of the dorsal venous network and winds upward around the radial border of the forearm, receiving tributaries from both surfaces. Below the front of the elbow it gives off the vena mediana cubiti (median basilic vein), which receives a communicating branch from the deep veins of the forearm and passes across to join the basilic vein. The cephalic vein then ascends in front of the elbow in the groove between the Brachioradialis and the Biceps brachii. It crosses superficial to the musculocutaneous nerve and ascends in the groove along the lateral border of the Biceps brachii. In the upper third of the arm it passes between the Pectoralis major and Deltoideus, where it is accom-
panied by the deltoid branch of the thoracoacromial artery. It pierces the coraco-
clavicular fascia and, crossing the axillary artery, ends in the axillary vein just
below the clavicle. Sometimes it communicates with the external jugular vein
by a branch which ascends in front of the clavicle.

The accessory cephalic vein (v. cephalica accessorii) arises either
from a small tributary plexus on
the back of the forearm or from
the ulnar side of the dorsal venous
network; it joins the cephalic be-
low the elbow. In some cases the
accessory cephalic springs from
the cephalic above the wrist and
joins it again higher up. A large
oblique branch frequently con-
nects the basilic and cephalic veins
on the back of the forearm.

The basilic vein (v. basilica)
(Fig. 574) begins in the ulnar part
of the dorsal venous network. It
runs up the posterior surface of
the ulnar side of the forearm and
inclines forward to the anterior
surface below the elbow, where it
is joined by the vena mediana
cubiti. It ascends obliquely in
the groove between the Biceps
brachii and Pronator teres and
crosses the brachial artery, from
which it is separated by the lacertus
fibrosus; filaments of the medial
antibrachial cutaneous nerve pass
both in front of and behind this
portion of the vein. It then runs
upward along the medial border
of the Biceps brachii, perforates
the deep fascia a little below the
middle of the arm, and, ascending
on the medial side of the brachial
artery to the lower border of the
Teres major, is continued onward
as the axillary vein.

The median antibrachial vein
(v. mediana antibrachii) drains the
venous plexus on the volar surface
of the hand. It ascends on the
ulnar side of the front of the fore-
arm and ends in the basilic vein or
in the vena mediana cubiti; in a
small proportion of cases it divides
into two branches, one of which
joins the basilic, the other the
cephalic, below the elbow.
The Deep Veins of the Upper Extremity.

The deep veins follow the course of the arteries, forming their venae comitantes. They are generally arranged in pairs, and are situated one on either side of the corresponding artery, and connected at intervals by short transverse branches.

**Deep Veins of the Hand.**—The superficial and deep volar arterial arches are each accompanied by a pair of venae comitantes which constitute respectively the superficial and deep volar venous arches, and receive the veins corresponding to the branches of the arterial arches; thus the common volar digital veins, formed by the union of the proper volar digital veins, open into the superficial, and the volar metacarpal veins into the deep volar venous arches. The dorsal metacarpal veins receive perforating branches from the volar metacarpal veins and end in the radial veins and in the superficial veins on the dorsum of the wrist.

The deep veins of the forearm are the venae comitantes of the radial and ulnar veins and constitute respectively the upward continuations of the deep and superficial volar venous arches; they unite in front of the elbow to form the brachial veins. The radial veins are smaller than the ulnar and receive the dorsal metacarpal veins. The ulnar veins receive tributaries from the deep volar venous arches and communicate with the superficial veins at the wrist; near the elbow they receive the volar and dorsal intersosseous veins and send a large communicating branch (profunda vein) to the vena mediana cubiti.

The brachial veins (un. brachiales) are placed one on either side of the brachial artery, receiving tributaries corresponding with the branches given off from that vessel; near the lower margin of the Subscapularis, they join the axillary vein; the medial one frequently joins the basilic vein.

These deep veins have numerous anastomoses, not only with each other, but also with the superficial veins.

The axillary vein (un. axillaris) begins at the lower border of the Teres major, as the continuation of the basilic vein, increases in size as it ascends, and ends at the outer border of the first rib as the subclavian vein. Near the lower border of the Subscapularis it receives the brachial veins and, close to its termination, the cephalic vein; its other tributaries correspond with the branches of the axillary artery. It lies on the medial side of the artery, which it partly overlaps; between the two vessels are the medial cord of the brachial plexus, the median, the ulnar,
and the medial anterior thoracic nerves. It is provided with a pair of valves opposite the lower border of the Subscapularis; valves are also found at the ends of the cephalic and subscapular veins.

The subclavian vein (v. subclavia), the continuation of the axillary, extends from the outer border of the first rib to the sternal end of the clavicle, where it unites with the internal jugular to form the innominate vein. It is in relation, in front, with the clavicle and Subclavius; behind and above, with the subclavian artery, from which it is separated medially by the Scalenus anterior and the phrenic nerve. Below, it rests in a depression on the first rib and upon the pleura. It is usually provided with a pair of valves, which are situated about 2.5 cm. from its termination.

The subclavian vein occasionally rises in the neck to a level with the third part of the subclavian artery, and occasionally passes with this vessel behind the Scalenus anterior.

Tributaries.—This vein receives the external jugular vein, sometimes the anterior jugular vein, and occasionally a small branch, which ascends in front of the clavicle, from the cephalic. At its angle of junction with the internal jugular, the left subclavian vein receives the thoracic duct, and the right subclavian vein the right lymphatic duct.

The Veins of the Thorax (Fig. 577)

The innominate veins (vv. anonymae; brachiocephalic veins) are two large trunks, placed one on either side of the root of the neck, and formed by the union of the internal jugular and subclavian veins of the corresponding side; they are devoid of valves.

The Right Innominate Vein (v. anonyma dextra) is a short vessel, about 2.5 cm. in length, which begins behind the sternal end of the clavicle, and, passing almost vertically downward, joins with the left innominate vein just below the cartilage
of the first rib, close to the right border of the sternum, to form the superior vena cava. It lies in front and to the right of the innominate artery; on its right side are the phrenic nerve and the pleura, which are interposed between it and the apex of the lung. This vein, at its commencement, receives the right vertebral vein; and,
lower down, the right internal mammary and right inferior thyroid veins, and sometimes the vein from the first intercostal space.

The Left Innominate Vein (v. anonyma sinistra), about 6 cm. in length, begins behind the sternal end of the clavicle and runs obliquely downward and to the right behind the upper half of the manubrium sterni to the sternal end of the first right costal cartilage, where it unites with the right innominate vein to form the superior vena cava. It is separated from the manubrium sterni by the Sternohyoideus and Sternothyreoides, the thymus or its remains, and some loose areolar tissue. Behind it are the three large arteries, innominate, left common carotid, and left subclavian, arising from the aortic arch, together with the vagus and phrenic nerves. The left innominate vein may occupy a higher level, crossing the jugular notch and lying directly in front of the trachea.

Tributaries.—Its tributaries are the left vertebral, left internal mammary, left inferior thyroid, and the left highest intercostal veins, and occasionally some thymic and pericardiac veins.

Peculiarities.—Sometimes the innominate veins open separately into the right atrium; in such cases the right vein takes the ordinary course of the superior vena cava; the left vein—left superior vena cava, as it is then termed—which may communicate by a small branch with the right one, passes in front of the root of the left lung, and, turning to the back of the heart, ends in the right atrium. This occasional condition in the adult is due to the persistence of the early fetal condition, and is the normal state of things in birds and some mammals.

The internal mammary veins (v. mammaries internae) are vena comitantes to the lower half of the internal mammary artery, and receive tributaries corresponding to the branches of the artery. They then unite to form a single trunk, which runs up on the medial side of the artery and ends in the corresponding innominate vein. The superior phrenic vein, i.e., the vein accompanying the pericardiacophrenic artery, usually opens into the internal mammary vein.

The inferior thyroid veins (v. thyroidei inferiora) two, frequently three or four, in number, arise in the venous plexus on the thyroid gland, communicating with the middle and superior thyroid veins. They form a plexus in front of the trachea, behind the Sternothyreoides. From this plexus, a left vein descends and joins the left innominate trunk, and a right vein passes obliquely downward and to the right across the innominate artery to open into the right innominate vein, just at its junction with the superior vena cava; sometimes the right and left veins open by a common trunk in the latter situation. These veins receive esophageal tracheal, and inferior laryngeal veins, and are provided with valves at their terminations in the innominate veins.

The highest intercostal vein (v. intercostalis suprema; superior intercostal vein) (right and left) drain the blood from the upper three or four intercostal spaces. The right vein (v. intercostalis suprema dextra) passes downward and opens into the vena azygos; the left vein (v. intercostalis suprema sinistra) runs across the arch of the aorta and the origins of the left subclavian and left common carotid arteries and opens into the left innominate vein. It usually receives the left bronchial vein, and sometimes the left superior phrenic vein, and communicates below with the accessory hemiazygos vein.

The superior vena cava (v. cava superior) drains the blood from the upper half of the body. It measures about 7 cm. in length, and is formed by the junction of the two innominate veins. It begins immediately below the cartilage of the right first rib close to the sternum, and, descending vertically behind the first and second intercostal spaces, ends in the upper part of the right atrium opposite the upper border of the third right costal cartilage: the lower half of the vessel is within the pericardium. In its course it describes a slight curve, the convexity of which is to the right side.
THE VEINS OF THE VERTEBRAL COLUMN

Relations.—In front are the anterior margins of the right lung and pleura with the pericardium intervening below; these separate it from the first and second intercostal spaces and from the second and third costal cartilages; behind it are the root of the right lung and the right vagus nerve. On its right side are the phrenic nerve and right pleura; on its left side, the commencement of the innominate artery and the ascending aorta, the latter overlapping it. Just before it pierces the pericardium, it receives the azygos vein and several small veins from the pericardium and other contents of the mediastinal cavity. The portion contained within the pericardium is covered, in front and laterally, by the serous layer of the membrane. The superior vena cava has no valves.

The azygos vein (v. azygos; vena azygos major) begins opposite the first or second lumbar vertebra, by a branch, the ascending lumbar vein (page 678); sometimes by a branch from the right renal vein, or from the inferior vena cava. It enters the thorax through the aortic hiatus in the diaphragm, and passes along the right side of the vertebral column to the fourth thoracic vertebra, where it arches forward over the root of the right lung, and ends in the superior vena cava, just before that vessel pierces the pericardium. In the aortic hiatus, it lies with the thoracic duct on the right side of the aorta; in the thorax it lies upon the intercostal arteries, on the right side of the aorta and thoracic duct, and is partly covered by pleura.

Tributaries.—It receives the right subcostal and intercostal veins, the upper three or four of these latter opening by a common stem, the highest superior intercostal vein. It receives the hemiazygos veins, several esophageal, mediastinal, and pericardial veins, and, near its termination, the right bronchial vein. A few imperfect valves are found in the azygos vein; but its tributaries are provided with complete valves.

The intercostal veins on the left side, below the upper three intercostal spaces, usually form two trunks, named the hemiazygos and accessory hemiazygos veins.

The Hemiazygos Vein (v. hemiazygos; vena azygos minor inferior) begins in the left ascending lumbar or renal vein. It enters the thorax, through the left crus of the diaphragm, and, ascending on the left side of the vertebral column, as high as the ninth thoracic vertebra, passes across the column, behind the aorta, esophagus, and thoracic duct, to end in the azygos vein. It receives the lower four or five intercostal veins and the subcostal vein of the left side, and some esophageal and mediastinal veins.

The Accessory Hemiazygos Vein (v. hemiazygos accessorio; vena azygos minor superior) descends on the left side of the vertebral column, and varies inversely in size with the highest left intercostal vein. It receives veins from the three or four intercostal spaces between the highest left intercostal vein and highest tributary of the hemiazygos; the left bronchial vein sometimes opens into it. It either crosses the body of the eighth thoracic vertebra to join the azygos vein or ends in the hemiazygos. When this vein is small, or altogether wanting, the left highest intercostal vein may extend as low as the fifth or sixth intercostal space.

In obstruction of the superior vena cava, the azygos and hemiazygos veins are one of the principal means by which the venous circulation is carried on, connecting as they do the superior and inferior venae cavae, and communicating with the common iliac veins by the ascending lumbar veins and with many of the tributaries of the inferior vena cava.

The Bronchial Veins (v. bronchiiales) return the blood from the larger bronchi, and from the structures at the roots of the lungs; that of the right side opens into the azygos vein, near its termination; that of the left side, into the highest left intercostal or the accessory hemiazygos vein. A considerable quantity of the blood which is carried to the lungs through the bronchial arteries is returned to the left side of the heart through the pulmonary veins.

The Veins of the Vertebral Column (Figs. 578, 579).

The veins which drain the blood from the vertebral column, the neighboring muscles, and the meninges of the medulla spinalis form intricate plexuses extending
along the entire length of the column; these plexuses may be divided into two
groups, external and internal, according to their positions inside or outside the
vertebral canal. The plexuses of the two groups anastomose freely with each other
and end in the intervertebral veins.

The **external vertebral venous plexuses** (*plexus venosi vertebrales externi; extraspinal veins*) best marked in the cervical region, consist of anterior and posterior
plexuses which anastomose freely with each other. The **anterior external plexuses**
lie in front of the bodies of the vertebrae, communicate with the basivertebral and
intervertebral veins, and receive tributaries from the vertebral bodies. The **posterior external plexuses** are placed partly on the posterior surfaces of the vertebral
arches and their processes, and partly between the deep dorsal muscles. They are
best developed in the cervical region, and there anastomose with the vertebral,
occipital, and deep cervical veins.

The **internal vertebral venous plexuses** (*plexus venosi vertebrales interni; intraspinal veins*) lie within the vertebral canal between the dura mater and the verte-
brae, and receive tributaries from the bones and from the medulla spinalis. They

![Posterior external plexus](image)

**Fig. 578.** Transverse section of a thoracic vertebra, showing the vertebral venous plexuses.

![Median sagittal section of two thoracic vertebrae](image)

**Fig. 579.** Median sagittal section of two thoracic vertebrae, showing the vertebral venous plexuses.

form a closer net-work than the external plexuses, and, running mainly in a vertical
direction, form four longitudinal veins, two in front and two behind; they therefore
may be divided into anterior and posterior groups. The **anterior internal plexuses**
consist of large veins which lie on the posterior surfaces of the vertebral bodies and
intervertebral fibrocartilages on either side of the posterior longitudinal ligament;
under cover of this ligament they are connected by transverse branches into which
the basivertebral veins open. The **posterior internal plexuses** are placed, one on
either side of the middle line in front of the vertebral arches and ligamenta flava,
and anastomose by veins passing through those ligaments with the posterior external
plexuses. The anterior and posterior plexuses communicate freely with one
another by a series of **venous rings** (*retia venosa vertebrae*), one opposite each
vertebra. Around the foramen magnum they form an intricate net-work which
opens into the vertebral veins and is connected above with the occipital sinus,
the basilar plexus, the condylid emissary vein, and the rete canalis hypoglossi.

The **basivertebral veins** (*ret. basivertebræ*) emerge from the foramina on the
posterior surfaces of the vertebral bodies. They are contained in large, tortuous
channels in the substance of the bones, similar in every respect to those found in the diploe of the cranial bones. They communicate through small openings on the front and sides of the bodies of the vertebrae with the anterior external vertebral plexuses, and converge behind to the principal canal, which is sometimes double toward its posterior part, and open by valved orifices into the transverse branches which unite the anterior internal vertebral plexuses. They become greatly enlarged in advanced age.

The **intervertebral veins** (v. **intervertebrales**) accompany the spinal nerves through the intervertebral foramina; they receive the veins from the medulla spinalis, drain the internal and external vertebral plexuses and end in the vertebral, intercostal, lumbar, and lateral sacral veins, their orifices being provided with valves.

The **veins of the medulla spinalis** (v. **spinales**; **veins of the spinal cord**) are situated in the pia mater and form a minute, tortuous, venous plexus. They emerge chiefly from the median fissures of the medulla spinalis and are largest in the lumbar region. In this plexus there are (1) two median longitudinal veins, one in front of the anterior fissure, and the other behind the posterior sulcus of the cord, and (2) four lateral longitudinal veins which run behind the nerve roots. They end in the intervertebral veins. Near the base of the skull they unite, and form two or three small trunks, which communicate with the vertebral veins, and then end in the inferior cerebellar veins, or in the inferior petrosal sinuses.

**THE VEINS OF THE LOWER EXTREMITY, ABDOMEN, AND PELVIS.**

The veins of the lower extremity are subdivided, like those of the upper, into two sets, **superficial** and **deep**; the superficial veins are placed beneath the integument between the two layers of superficial fascia; the deep veins accompany the arteries. Both sets of veins are provided with valves, which are more numerous in the deep than in the superficial set. Valves are also more numerous in the veins of the lower than in those of the upper limb.

**The Superficial Veins of the Lower Extremity.**

The **superficial veins** of the lower extremity are the **great** and **small saphenous veins** and their tributaries.

On the **dorsum of the foot** the **dorsal digital veins** receive, in the clefts between the toes, the **intercapitular veins** from the plantar cutaneous venous arch and join to form short **common digital veins** which unite across the distal ends of the metatarsal bones in a **dorsal venous arch**. Proximal to this arch is an irregular venous network which receives tributaries from the deep veins and is joined at the sides of the foot by a **medial** and a **lateral marginal vein**, formed mainly by the union of branches from the superficial parts of the sole of the foot.

On the **sole of the foot** the superficial veins form a **plantar cutaneous venous arch** which extends across the roots of the toes and opens at the sides of the foot into the medial and lateral marginal veins. Proximal to this arch is a **plantar cutaneous venous net-work** which is especially dense in the fat beneath the heel; this net-work communicates with the cutaneous venous arch and with the deep veins, but is chiefly drained into the medial and lateral marginal veins.

The **great saphenous vein** (**v. saphena magna; internal or long saphenous vein**) (Fig. 581), the longest vein in the body, begins in the medial marginal vein of the dorsum of the foot and ends in the femoral vein about 3 cm. below the inguinal ligament. It ascends in front of the tibial malleolus and along the medial side of the leg in relation with the saphenous nerve. It runs upward behind the medial
condyles of the tibia and femur and along the medial side of the thigh and, passing through the fossa ovalis, ends in the femoral vein.

**Tributaries.**—At the ankle it receives branches from the sole of the foot through the medial marginal vein; in the leg it anastomoses freely with the small saphenous vein, communicates with the anterior and posterior tibial veins and receives many cutaneous veins; in the thigh it communicates with the femoral vein and receives numerous tributaries; those from the medial and posterior parts of the thigh frequently unite to form a large accessory saphenous vein which joins the main vein at a variable level. Near the fossa ovalis (Fig. 580) it is joined by the superficial epigastric, superficial iliac circumflex, and superficial external pudendal veins. A vein, named the thoracoepigastric, runs along the lateral aspect of the trunk between the superficial epigastric vein below and the lateral thoracic vein above and establishes an important communication between the femoral and axillary veins.

**Fig. 580.**—The great saphenous vein and its tributaries at the fossa ovalis.

The valves in the great saphenous vein vary from ten to twenty in number; they are more numerous in the leg than in the thigh.

The small saphenous vein (v. saphena parva; external or short saphenous vein) (Fig. 582) begins behind the lateral malleolus as a continuation of the lateral marginal vein; it first ascends along the lateral margin of the tendocalcaneus, and then crosses it to reach the middle of the back of the leg. Running directly upward, it perforates the deep fascia in the lower part of the popliteal fossa, and ends in the popliteal vein, between the heads of the Gastrocnemius. It commu-
THE DEEP VEINS OF THE LOWER EXTREMITY

nects with the deep veins on the dorsum of the foot, and receives numerous large tributaries from the back of the leg. Before it pierces the deep fascia, it gives off a branch which runs upward and forward to join the great saphenous vein. The small saphenous vein possesses from nine to twelve valves, one of which is always found near its termination in the popliteal vein. In the lower third of the leg the small saphenous vein is in close relation with the sural nerve, in the upper two-thirds with the medial sural cutaneous nerve.

The Deep Veins of the Lower Extremity.

The deep veins of the lower extremity accompany the arteries and their branches; they possess numerous valves.

The plantar digital veins (er. digitales plantares) arise from plexuses on the plantar surfaces of the digits, and, after sending intercapital veins to join the
dorsal digital veins, unite to form four metatarsal veins; these run backward in the metatarsal spaces, communicate, by means of perforating veins, with the veins on the dorsum of the foot, and unite to form the deep plantar venous arch which lies alongside the plantar arterial arch. From the deep plantar venous arch the medial and lateral plantar veins run backward close to the corresponding arteries and, after communicating with the great and small saphenous veins, unite behind the medial malleolus to form the posterior tibial veins.

The posterior tibial veins (v. tibiales posteriores) accompany the posterior tibial artery, and are joined by the peroneal veins.

The anterior tibial veins (v. tibiales anteriores) are the upward continuation of the vena comitantes of the dorsalis pedis artery. They leave the front of the leg by passing between the tibia and fibula, over the interosseous membrane, and unite with the posterior tibial, to form the popliteal vein.

The Popliteal Vein (v. poplitea) (Fig. 583) is formed by the junction of the anterior and posterior tibial veins at the lower border of the Popliteus; it ascends through the popliteal fossa to the aperture in the Adductor magnus, where it becomes the femoral vein. In the lower part of its course it is placed medial to the artery; between the heads of the Gastrocnemius it is superficial to that vessel; but above the knee-joint, it is close to its lateral side. It receives tributaries corresponding to the branches of the popliteal artery, and it also receives the small saphenous vein. The valves in the popliteal vein are usually four in number.

The femoral vein (v. femorals) accompanies the femoral artery up to the upper two-thirds of the thigh. In the lower part of its course it lies lateral to the artery; higher up, it is behind it; and at the inguinal ligament, it lies on its medial side, and on the same plane. It receives numerous muscular tributaries, and about 4 cm. below the inguinal ligament is joined by the v. profunda femoris; near its termination it is joined by the great saphenous vein. The valves in the femoral vein are three in number.

The Deep Femoral Vein (v. profunda femoris) receives tributaries corresponding to the perforating branches of the profunda artery, and through these establishes communications with the popliteal vein below and the inferior gluteal vein above. It also receives the medial and lateral femoral circumflex veins.

The Veins of the Abdomen and Pelvis (Figs. 585, 586, 587).

The external iliac vein (v. iliaca externa), the upward continuation of the femoral vein, begins behind the inguinal ligament, and, passing upward along the brim of the lesser pelvis, ends opposite the sacroiliac articulation, by uniting with the hypogastric vein to form the common iliac vein. On the right side, it lies at first medial to the artery: but, as it passes upward, gradually inclines behind it. On the left side, it lies altogether on the medial side of the artery. It frequently contains one, sometimes two, valves.

Tributaries.—The external iliac vein receives the inferior epigastric, deep iliac circumflex, and pubic veins.

The Inferior Epigastric Vein (v. epigastrica inferior; deep epigastric vein) is formed
by the union of the vena comitantes of the inferior epigastric artery, which communicate above with the superior epigastric vein; it joins the external iliac about 1.25 cm. above the inguinal ligament.

The Deep Iliac Circumflex Vein (v. circumsheca ilium profunda) is formed by the union of the vena comitantes of the deep iliac circumflex artery, and joins the external iliac vein about 2 cm. above the inguinal ligament.

The Pubic Vein communicates with the obturator vein in the obturator foramen, and ascends on the back of the pubis to the external iliac vein.

The hypogastric vein (v. hypogastrica; internal iliac vein) begins near the upper part of the greater sciatic foramen, passes upward behind and slightly medial to the hypogastric artery and, at the brim of the pelvis, joins with the external iliac to form the common iliac vein.

**TRIBUTARIES.**—With the exception of the fetal umbilical vein which passes upward and backward from the umbilicus to the liver, and the iliolumbar vein which usually joins the common iliac vein, the tributaries of the hypogastric vein correspond with the branches of the hypogastric artery. It receives (a) the gluteal, internal pudendal, and obturator veins, which have their origins outside the pelvis; (b) the lateral sacral veins, which lie in front of the sacrum; and (c) the middle hemorrhoidal, vesical, uterine, and vaginal veins, which originate in venous plexuses connected with the pelvic viscera.
1. The Superior Gluteal Veins (vea. gluteae superiorae; gluteal veins) are vena comitantes of the superior gluteal artery; they receive tributaries from the buttock corresponding with the branches of the artery, and enter the pelvis through the greater sciatic foramen, above the Piriformis, and frequently unite before ending in the hypogastric vein.

2. The Inferior Gluteal Veins (vea. gluteae inferiores; sciatic veins), or vena comitantes of the inferior gluteal artery, begin on the upper part of the back of the thigh, where they anastomose with the medial femoral circumflex and first perforating veins. They enter the pelvis through the lower part of the greater sciatic foramen and join to form a single stem which opens into the lower part of the hypogastric vein.

3. The Internal Pudendal Veins (internal pudic veins) are the vena comitantes of the internal pudendal artery. They begin in the deep veins of the penis which issue from the corpus cavernosum penis, accompany the internal pudendal artery, and unite to form a single vessel, which ends in the hypogastric vein. They receive the veins from the urethral bulb, and the perineal and inferior hemorrhoidal veins.
THE VEINS OF THE ABDOMEN AND PELVIS

Fig. 586. — The iliac veins. (Poirier and Charpy.)

Fig. 587. — Scheme of the anastomosis of the veins of the rectum. (Poirier and Charpy.)
The deep dorsal vein of the penis communicates with the internal pudendal veins, but ends mainly in the pudendal plexus.

4. The Obturator Vein (v. obturatoria) begins in the upper portion of the adductor region of the thigh and enters the pelvis through the upper part of the obturator foramen. It runs backward and upward on the lateral wall of the pelvis below the obturator artery, and then passes between the ureter and the hypogastric artery, to end in the hypogastric vein.

5. The Lateral Sacral Veins (v. sacrals laterales) accompany the lateral sacral arteries on the anterior surface of the sacrum and end in the hypogastric vein.

6. The Middle Hemorrhoidal Vein (v. hemorrhoidalis media) takes origin in the hemorrhoidal plexus and receives tributaries from the bladder, prostate, and seminal vesicle; it runs laterally on the pelvic surface of the Levator ani to end in the hypogastric vein.

The hemorrhoidal plexus (plexus hemorrhoidalis) surrounds the rectum, and communicates in front with the vesical plexus in the male, and the uterovaginal plexus in the female. It consists of two parts, an internal in the submucosa, and an external outside the muscular coat. The internal plexus presents a series of dilated pouches which are arranged in a circle around the tube, immediately above the anal orifice, and are connected by transverse branches.

The lower part of the external plexus is drained by the inferior hemorrhoidal veins into the internal pudendal vein; the middle part by the middle hemorrhoidal vein which joins the hypogastric vein; and the upper part by the superior hemorrhoidal vein which forms the commencement of the inferior mesenteric vein, a tributary of the portal vein. A free communication between the portal and systemic venous systems is established through the hemorrhoidal plexus.

The veins of the hemorrhoidal plexus are contained in very loose, connective tissue, so that they get less support from surrounding structures than most other veins, and are less capable of resisting increased blood-pressure.

The pudendal plexus (plexus pudendalis; vesicoprostatic plexus) lies behind the arcuate pubic ligament and the lower part of the symphysis pubis, and in front of the bladder and prostate. Its chief tributary is the deep dorsal vein of the penis, but it also receives branches from the front of the bladder and prostate. It communicates with the vesical plexus and with the internal pudendal vein and drains into the vesical and hypogastric veins. The prostatic veins form a well-marked prostatic plexus which lies partly in the fascial sheath of the prostate and partly between the sheath and the prostatic capsule. It communicates with the pudendal and vesical plexuses.

The vesical plexus (plexus vesicalis) envelops the lower part of the bladder and the base of the prostate and communicates with the pudendal and prostatic plexuses. It is drained, by means of several vesical veins, into the hypogastric veins.

The Dorsal Veins of the Penis (v. dorsales penis) are two in number, a superficial and a deep. The superficial vein drains the prepuce and skin of the penis, and, running backward in the subcutaneous tissue, inclines to the right or left, and opens into the corresponding superficial external pudendal vein, a tributary of the great saphenous vein. The deep vein lies beneath the deep fascia of the penis; it receives the blood from the glans penis and corpora cavernosa penis and courses backward in the middle line between the dorsal arteries; near the root of the penis it passes between the two parts of the suspensory ligament and then through an aperture between the arcuate pubic ligament and the transverse ligament of the pelvis, and divides into two branches, which enter the pudendal plexus. The deep vein also communicates below the symphysis pubis with the internal pudendal vein.

The uterine plexuses lie along the sides and superior angles of the uterus between the two layers of the broad ligament, and communicate with the ovarian and vaginal plexuses. They are drained by a pair of uterine veins on either side: these
arise from the lower part of the plexuses, opposite the external orifice of the uterus, and open into the corresponding hypogastric vein.

The **vaginal plexuses** are placed at the sides of the vagina; they communicate with the uterine, vesical, and hemorrhoidal plexuses, and are drained by the vaginal veins, one on either side, into the hypogastric veins.

The **common iliac veins** (*v. iliaca communes*) are formed by the union of the external iliac and hypogastric veins, in front of the sacroiliac articulation; passing obliquely upward toward the right side, they end upon the fifth lumbar vertebra, by uniting with each other at an acute angle to form the inferior vena cava. The right common iliac is shorter than the left, nearly vertical in its direction, and ascends behind and then lateral to its corresponding artery.

The **left common iliac**, longer than the right and more oblique in its course, is at first situated on the medial side of the corresponding artery, and then behind the right common iliac. Each common iliac receives the iliolumbar, and sometimes the lateral sacral veins. The left receives, in addition, the middle sacral vein. No valves are found in these veins.

The **Middle Sacral Veins** (*v. sacrales mediales*) accompany the corresponding artery along the front of the sacrum, and join to form a single vein, which ends in the left common iliac vein; sometimes in the angle of junction of the two iliac veins.

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**Peculiarities.**—The left common iliac vein, instead of joining with the right in its usual position, occasionally ascends on the left side of the aorta as high as the kidney, where, after receiving the left renal vein, it crosses over the aorta, and then joins with the right vein to form the vena cava. In these cases, the two common iliacs are connected by a small communicating branch at the spot where they are usually united.

The **inferior vena cava** (*v. cava inferior*) (Fig. 577), returns to the heart the blood from the parts below the diaphragm. It is formed by the junction of the two common iliac veins, on the right side of the fifth lumbar vertebra. It ascends along
the front of the vertebral column, on the right side of the aorta, and, having reached
the liver, is continued in a groove on its posterior surface. It then perforates
the diaphragm between the median and right portions of its central tendon;
it subsequently inclines forward and mediallyward for about 2.5 cm., and, piercing
the fibrous pericardium, passes behind the serous pericardium to open into the
lower and back part of the right atrium. In front of its atrial orifice is a semilunar
valve, termed the \textit{valve of the inferior vena cava}; this is rudimentary in the adult,
but is of large size and exercises an important function in the fetus (see page 540).

\textbf{Relations.}---The \textit{abdominal portion} of the inferior vena cava is in relation \textit{in front}, from below
upward, with the right common iliac artery, the mesentery, the right internal spermatic artery,
the inferior part of the duodenum, the pancreas, the common bile duct, the portal vein, and the
posterior surface of the liver; the last partly overlaps and occasionally completely surrounds it;
\textit{behind}, with the vertebral column, the right Psoas major, the right crus of the diaphragm, the
right inferior phrenic, suprarenal, renal and lumbar arteries, right sympathetic trunk and right
celiac ganglion, and the medial part of the right suprarenal gland; on the \textit{right side}, with the
right kidney and ureter; on the \textit{left side}, with the aorta, right crus of the diaphragm, and the
caudate lobe of the liver.

The \textit{thoracic portion} is only about 2.5 cm. in length, and is situated partly inside and partly
outside the pericardial sac. The \textit{extrapericardial part} is separated from the right pleura and
lung by a fibrous band, named the \textit{right phrenicopericardiac ligament}. This ligament, often
feebly marked, is attached below to the margin of the vena-caval opening in the diaphragm, and
above to the pericardium in front of and behind the root of the right lung. The \textit{intrapericardiac
part} is very short, and is covered antero-laterally by the serous layer of the pericardium.

\textbf{Peculiarities.---In Position.}---This vessel is sometimes placed on the left side of the aorta,
as high as the left renal vein, and, after receiving this vein, crosses over to its usual position on
the right side; or it may be placed altogether on the left side of the aorta, and in such a case the
abdominal and thoracic viscera, together with the great vessels, are all transposed.

\textbf{Point of Termination.}---Occasionally the inferior vena cava joins the ayzygos vein, which is
then of large size. In such cases, the superior vena cava receives the whole of the blood from
the body before transmitting it to the right atrium, except the blood from the hepatic veins,
which passes directly into the right atrium.

\textbf{Tributaries.}---The inferior vena cava receives the following veins:

\begin{itemize}
  \item \textbf{Lumbar.}
  \item \textbf{Right Spermatic or Ovarian.}
  \item \textbf{Renal.}
  \item \textbf{Suprarenal.}
  \item \textbf{Inferior Phrenic.}
  \item \textbf{Hepatic.}
\end{itemize}

The \textit{Lumbar Veins} (\textit{ve. lumbales}) four in number on each side, collect the blood
by dorsal tributaries from the muscles and integument of the loins, and by abdomi-
nal tributaries from the walls of the abdomen, where they communicate with the
epigastric veins. At the vertebral column, they receive veins from the vertebral
plexuses, and then pass forward, around the sides of the bodies of the vertebrae,
beneath the Psoas major, and end in the back part of the inferior vena cava. The left
lumbar veins are longer than the right, and pass behind the aorta. The lumbar
veins are connected together by a longitudinal vein which passes in front of the
transverse processes of the lumbar vertebrae, and is called the \textit{ascending lumbar};
it forms the most frequent origin of the corresponding ayzygos or hemiayzygos vein,
and serves to connect the common iliac, iliolumbar, and azygos or hemiayzygos
veins of its own side of the body.

The \textit{Spermatic Veins} (\textit{ve. spermatica}) (Fig. 590) emerge from the back of the
tests, and receive tributaries from the epididymis; they unite and form a convolu-
ted plexus, called the \textit{pampiniform plexus}, which constitutes the greater mass of
the spermatic cord; the vessels composing this plexus are very numerous, and
ascend along the cord, in front of the ductus deferens. Below the subcutaneous
inguinal ring they unite to form three or four veins, which pass along the inguinal
canal, and, entering the abdomen through the abdominal inguinal ring, coalesce
to form two veins, which ascend on the Psoas major, behind the peritoneum, lying
one on either side of the internal spermatic artery. These unite to form a single
vein, which opens on the right side into the inferior vena cava, \textit{at an acute angle};
on the left side into the left renal vein, \textit{at a right angle}. The spermatic veins
are provided with valves.¹ The left spermatic vein passes behind the iliac colon, and is thus exposed to pressure from the contents of that part of the bowel.

The Ovarian Veins (cf. ovaricæ) correspond with the spermatic in the male; they form a plexus in the broad ligament near the ovary and uterine tube, and communicate with the uterine plexus. They end in the same way as the spermatic veins in the male. Valves are occasionally found in these veins. Like the uterine veins, they become much enlarged during pregnancy.

The Renal Veins (cf. renales) are of large size, and placed in front of the renal arteries. The left is longer than the right, and passes in front of the aorta, just below the origin of the superior mesenteric artery. It receives the left spermatic and left inferior phrenic veins, and, generally, the left suprarenal vein. It opens into the inferior vena cava at a slightly higher level than the right.

The Suprarenal Veins (cf. suprarenales) are two in number: the right ends in the inferior vena cava; the left, in the left renal or left inferior phrenic vein.

The Inferior Phrenic Veins (cf. phrenicæ inferiores) follow the course of the inferior phrenic arteries; the right ends in the inferior vena cava; the left is often represented by two branches, one of which ends in the left renal or suprarenal vein, while the other passes in front of the esophageal hiatus in the diaphragm and opens into the inferior vena cava.

¹ Rovington has pointed out that valves are usually found at the orifices of both the right and left spermatic veins. When no valves exist at the opening of the left spermatic vein into the left renal vein, valves are generally present in the left renal vein within 6 mm. from the orifice of the spermatic vein. — Journal of Anatomy and Physiology, vii, 163.
The **Hepatic Veins** (an. *hepatica*) commence in the substance of the liver, in the terminations of the portal vein and hepatic artery, and are arranged in two groups, upper and lower. The **upper group** usually consists of three large veins, which converge toward the posterior surface of the liver, and open into the inferior vena cava, while that vessel is situated in the groove on the back part of the liver. The veins of the **lower group** vary in number, and are of small size; they come from the right and caudate lobes. The hepatic veins run singly, and are in direct contact with the hepatic tissue. They are destitute of valves.

**THE PORTAL SYSTEM OF VEINS** (Fig. 591).

The **portal system** includes all the veins which drain the blood from the abdominal part of the digestive tube (with the exception of the lower part of the rectum) and from the spleen, pancreas, and gall-bladder. From these viscera the blood is conveyed to the liver by the **portal vein**. In the liver this vein ramifies like an artery and ends in capillary-like vessels termed **sinusoids**, from which the blood is
conveyed to the inferior vena cava by the hepatic veins. From this it will be seen that the blood of the portal system passes through two sets of minute vessels, viz., (a) the capillaries of the digestive tube, spleen, pancreas, and gall-bladder; and (b) the sinusoids of the liver. In the adult the portal vein and its tributaries are destitute of valves; in the fetus and for a short time after birth valves can be demonstrated in the tributaries of the portal vein; as a rule they soon atrophy and disappear, but in some subjects they persist in a degenerate form.

The portal vein (vena portae) is about 8 cm. in length, and is formed at the level of the second lumbar vertebra by the junction of the superior mesenteric and lienal veins, the union of these veins taking place in front of the inferior vena cava and behind the neck of the pancreas. It passes upward behind the superior part of the duodenum and then ascends in the right border of the lesser omentum to the right extremity of the porta hepatis, where it divides into a right and a left branch, which accompany the corresponding branches of the hepatic artery into the substance of the liver. In the lesser omentum it is placed behind and between the common bile duct and the hepatic artery, the former lying to the right of the latter. It is surrounded by the hepatic plexus of nerves, and is accompanied by numerous lymphatic vessels and some lymph glands. The right branch of the portal vein enters the right lobe of the liver, but before doing so generally receives the cystic vein. The left branch, longer but of smaller caliber than the right, crosses the left sagittal fossa, gives branches to the caudate lobe, and then enters the left lobe of the liver. As it crosses the left sagittal fossa it is joined in front by a fibrous cord, the ligamentum teres (obliterated umbilical vein), and is united to the inferior vena cava by a second fibrous cord, the ligamentum venosum (obliterated ductus venosus).

Tributaries.—The tributaries of the portal vein are:

- Lienal
- Superior Mesenteric
- Coronary
- Pyloric
- Cystic
- Parumbilical

The lienal vein (v. lienalis; splenic vein) commences by five or six large branches which return the blood from the spleen. These unite to form a single vessel, which passes from left to right, grooving the upper and back part of the pancreas, below the lineal artery, and ends behind the neck of the pancreas by uniting at a right angle with the superior mesenteric to form the portal vein. The lienal vein is of large size, but is not tortuous like the artery.

Tributaries.—The lienal vein receives the short gastric veins, the left gastrospliopic vein, the pancreatic veins, and the inferior mesenteric veins.

The short gastric veins (v. gastrice breves), four or five in number, drain the fundus and left part of the greater curvature of the stomach, and pass between the two layers of the gastrolienal ligament to end in the lienal vein or in one of its large tributaries.

The left gastrospliopic vein (v. gastrospliipica sinistra) receives branches from the antero-superior and postero-inferior surfaces of the stomach and from the greater omentum; it runs from right to left along the greater curvature of the stomach and ends in the commencement of the lienal vein.

The pancreatic veins (v. pancreatica) consist of several small vessels which drain the body and tail of the pancreas, and open into the trunk of the lienal vein.

The inferior mesenteric vein (v. mesenterica inferior) returns blood from the rectum and the sigmoid, and descending parts of the colon. It begins in the rectum as the superior hemorroidal vein, which has its origin in the hemorroidal plexus, and through this plexus communicates with the middle and inferior hemorroidal veins. The superior hemorroidal vein leaves the lesser pelvis and crosses the left common iliac vessels with the superior hemorroidal artery, and is continued upward as the inferior mesenteric vein. This vein lies to the left of its artery, and ascends behind the peritoneum and in front of the left Psas major;
it then passes behind the body of the pancreas and opens into the lienal vein; sometimes it ends in the angle of union of the lienal and superior mesenteric veins.

**Tributaries.**—The inferior mesenteric vein receives the sigmoid veins from the sigmoid colon and iliac colon, and the left colic vein from the descending colon and left colic flexure.

The *Superior Mesenteric Vein* (*v. mesenterica superior*) returns the blood from the small intestine, from the cecum, and from the ascending and transverse portions of the colon. It begins in the right iliac fossa by the union of the veins which drain the terminal part of the ileum, the cecum, and vermiform process, and ascends between the two layers of the mesentery on the right side of the superior mesenteric artery. In its upward course it passes in front of the right ureter, the inferior vena cava, the inferior part of the duodenum, and the lower portion of the head of the pancreas. Behind the neck of the pancreas it unites with the lienal vein to form the portal vein.

**Tributaries.**—Besides the tributaries which correspond with the branches of the superior mesenteric artery, viz., the intestinal, ileocolic, right colic, and middle colic veins, the superior mesenteric vein is joined by the right gastroepiploic and pancreaticoduodenal veins.

The right *gastroepiploic vein* (*v. gastroepiploica dextra*) receives branches from the greater omentum and from the lower parts of the antero-superior and posteroinferior surfaces of the stomach; it runs from left to right along the greater curvature of the stomach between the two layers of the greater omentum.

The *pancreaticoduodenal veins* (*v. pancreaticoduodenales*) accompany their corresponding arteries; the lower of the two frequently joins the right gastroepiploic vein.

The *Coronary Vein* (*v. coronaria ventriculi; gastric vein*) derives tributaries from both surfaces of the stomach; it runs from right to left along the lesser curvature of the stomach, between the two layers of the lesser omentum, to the esophageal opening of the stomach, where it receives some esophageal veins. It then turns backward and passes from left to right behind the omental bursa and ends in the portal vein.

The *Pyloric Vein* is of small size, and runs from left to right along the pyloric portion of the lesser curvature of the stomach, between the two layers of the lesser omentum, to end in the portal vein.

The *Cystic Vein* (*v. cystica*) drains the blood from the gall-bladder, and, accompanying the cystic duct, usually ends in the right branch of the portal vein.

**Parumbilical Veins**(w. *parumbilicales*).—In the course of the ligamentum teres of the liver and of the middle umbilical ligament, small veins (*parumbilical*) are found which establish an anastomosis between the veins of the anterior abdominal wall and the portal, hypogastric, and iliac veins. The best marked of these small veins is one which commences at the umbilicus and runs backward and upward in, or on the surface of, the ligamentum teres between the layers of the falciform ligament to end in the left portal vein.

Collateral venous circulation to relieve portal obstruction in the liver may be effected by communications between (a) the gastric veins and the esophageal veins which often project as a varicose bunch into the stomach, emptying themselves into the hemiazygos vein; (b) the veins of the colon and duodenum and the left renal vein; (c) the accessory portal system of Sappey, branches of which pass in the round and falciform ligaments (particularly the latter) to unite with the epigastric and internal mammary veins, and through the diaphragmatic veins with theazygos; a single large vein, shown to be a parumbilical vein, may pass from the hilus of the liver by the round ligament to the umbilicus, producing there a bunch of prominent varicose veins known as the caput medius; (d) the veins of Retzius, which connect the intestinal veins with the inferior vena cava and its retroperitoneal branches; (e) the inferior mesenteric veins, and the hemorrhoidal veins that open into the hypogastrics; (f) very rarely the ductus venosus remains patent, affording a direct connection between the portal vein and the inferior vena cava.