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THE VENOUSE ANASTOMOSES. THE FETAL CIRCULATION

Methodical Instructions

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This study guide is recommended for the first-year students (specialty 222 "Medicine", field of knowledge 22 "Health care", educational qualification "Master of Medicine", and professional qualification "Doctor of Medicine") to facilitate their studying of the cardiovascular system. The study guide is divided into three parts: the hepatic portal vein, the venous anastomoses and a fetal circulation of the human body.

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LIST OF ABBREVIATION

- **SVC** – Superior Vena Cava
- **IVC** – Inferior vena cava
- **HPV** – Hepatic portal vein
- **SMV** – Superior mesenteric vein
- **IMV** – Inferior mesenteric vein
- **CIV** – common iliac vein
- **EIV** – External iliac vein
- **IIV** – Internal iliac vein

FORMATION OF THE ROOTS OF SUPERIOR AND INFERIOR VENAE CAVA

The **greater or systemic circulation** starts from left ventricle of the heart. The oxygenated blood passed to the aortae and is directed through arteries to all organs of the human body. A gas exchange occurs inside of tissue of internal organs and deoxygenated blood passes to smallest veins and after it distributes to bigger veins. Venous blood from the region of head, neck and upper limbs distributes to superior venae cava (SVC) and forms the **root inside of the right atrium of the heart**. Deoxygenated blood from lower limbs, abdominal cavity and thoracic cavity flows directly into right atrium of the heart and form the root of inferior venae cava (IVC) (Fig. 1).

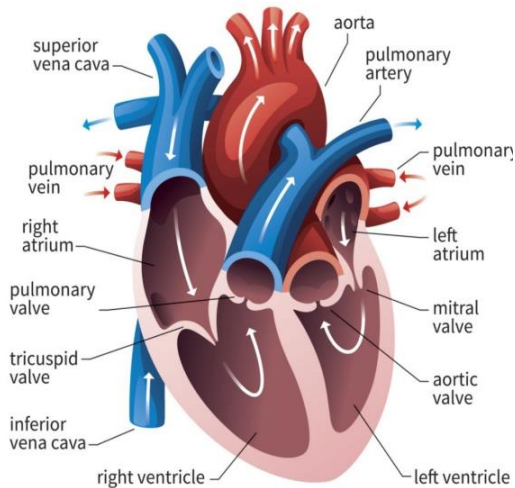


Fig. 1. Hemocirculation in the chambers of the heart

The **pulmonary circulation (or lesser circle of circulation)** arises from the right ventricle. From this chamber arises a big vessel – pulmonary trunk. This trunk splits into the left and the right pulmonary arteries that carry venous blood to the smallest branches of the pulmonary artery and to capillaries of parenchyma of the lungs where oxygenation occurs. Oxygenated blood is carried by the pulmonary veins that open into left atrium and passes through **superior and inferior right and left orifices of pulmonary vines NB! (these vessels carry oxygenated blood)**.

THE HEPATIC PORTAL VEIN (v. portae, «hepatis», Greek)

This is the biggest visceral vein which drains blood from unpaired abdominal internal organs. Its length is 5–6 cm and its diameter is 11–18 mm (Fig. 2).

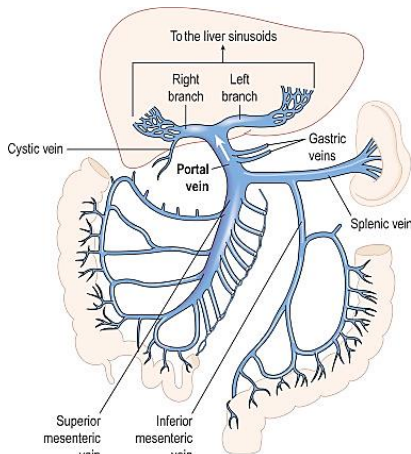


Fig. 2. Formation of the portal hepatic vein

Topography. The portal vein inside of *hepato-duodenal ligament* behind the *common bile duct*. Formation of the portal vein from unpaired organs of abdominal cavity are as follows: from the stomach, the small and the large intestine (except rectum), the pancreas and the spleen (Fig. 3).

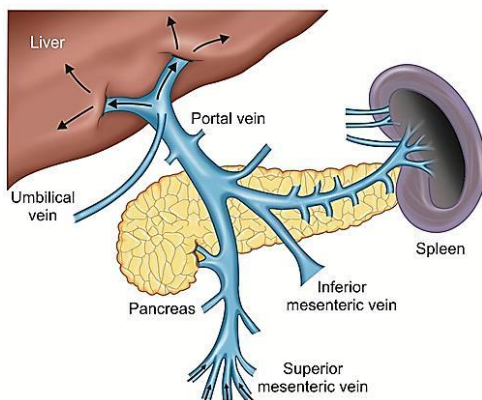


Fig. 3. Venous derange in Hepatic Portal vein

The Venose Anastomoses. The Fetal Circulation

There are 3 main tributaries of hepatic veins:

- Superior mesocolic vein
- Inferior mesocolic vein
- Splenic vein (V. lienalis).

They adjoin behind the head of the pancreas and forms the **PORTAL VEIN**.

Divisions of the portal vein. After entering the hilum of the liver, the portal vein bifurcates into *right and left branches* (according to the right and the left lobes of the liver) after that it goes to *segmental veins*, then to *smallest veins* and then to *interlobular veins*. Inside of the hepatic lobules, interlobular veins form wide *sinusoidal capillaries* that go into *v. centralis of* the center of hepatocytes (Fig. 4). From each of the hepatic lobules come out *sublobular v.v.* which split and form **3–4 hepatic veins**.

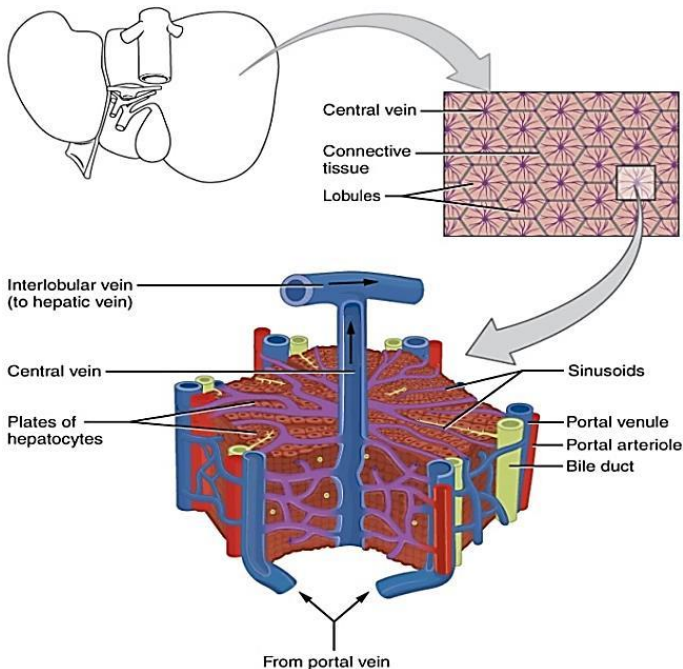


Fig. 4. Anatomic-functional unit of the liver (a hepatocyte) with vessels

It is the blood which came to inferior vena cava along hepatic vein which contains two capillary networks (the one of them lays in the walls of gastro-intestinal tract and the other network is in parenchyma of the liver).

• **Clinical application.** The liver has many functions such as detoxification of the waste products and medicine, hemocytopenesis during intrauterine term, the production of the bile, bilirubin metabolism, the glucagon conversion etc.

The waste products are usually present in large and small intestine. They pass with venous blood through such veins as *jejunalis* and *ilealis*, *iliocolica*, *gastroepiplica dextra*, *appendicularis*, *colicea media* and *dextra* est. into tributaries of the superior and inferior mesenteric veins and pass into hilum of the liver. **PV** (portal hepatic vein) enters the hilum of this organ for detoxification. Inside of the parenchyma of this organ, PV divides into **right and left lobar hepatic vein**. Inside of parenchyma, these veins separate into smaller veins and form the **fabulous venous network** (rete mirabile). Thus, the capillary network is formed for detoxification of waste products. After this process clean venous blood goes to **Inferior vena cava (IVC)** through **hepatic vein** (Fig. 5).

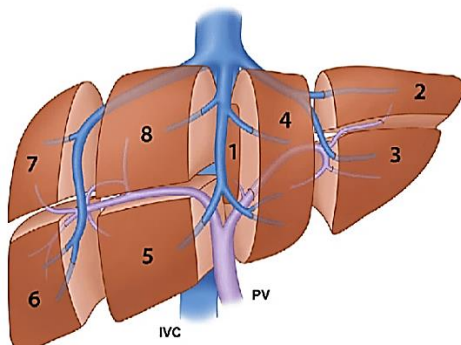


Fig. 5. Divisions of veins in parenchyma of the liver

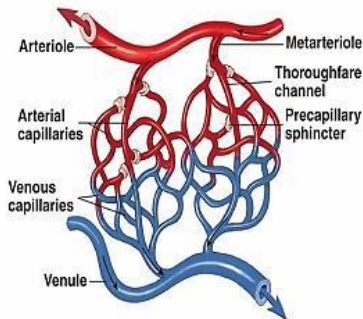
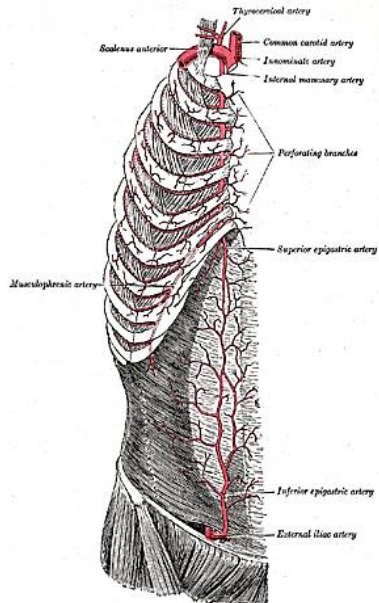
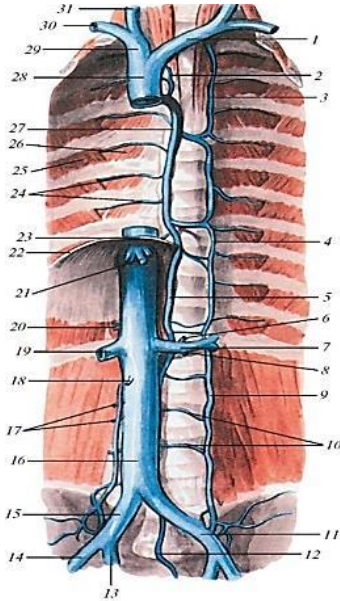
DEFINITION OF ANASTOMOSIS: from Greek «ana-» passed through and «stoma-» an orifice – is a surgical connection between two structures. It usually means a connection that is created between tubular structures such as blood vessels (**arteria or veins**), through which blood flow is possible in two directions.

CLASSIFICATION OF THE VASCULAR ANASTOMOSES

1. THE VENOUS ANASTOMOSIS.
2. THE ARTERIAL ANASTOMOSIS.
3. ARTERIOVENOUS ANASTOMOSIS (mixed, between arteries & veins are forms capillary network).

The Venose Anastomoses. The Fetal Circulation

1. venose 2. arterial anastomosis 3. capillaris (a. and v.) anastomosis



THE VENOUS ANASTOMOSES ARE CLASSIFIED:

- I. Cava-caval anastomosis (between of Superior Venae Cava & Inferior Vena Cava).
- II. Porto-caval anastomosis (between of Portal Hepatic Vein & Superior Vena Cava or Inferior Vena Cava).
- III. Porto-cava-caval anastomosis (between Portal Hepatic Vein and Superior Vena Cava and Inferior Vena Cava).

THE PORTO-CAVA-CAVAL ANASTOMOSIS AROUND UMBILICUS

The region for anastomosis is situated under the skin of the umbilical region.

The central part of anastomoses arises from the skin of umbilicus and from there venous blood passes to *paraumbilical vein* and after that it drains into **hepatic portal vein**.

The upper part of anastomosis: venous blood from upper part of the skin of umbilical region goes to *superior epigastric vein* after that the blood ascends and joins *internal thoracic vein*, then it goes to *subclavian vein* and join **brachiocephalic v.**, and drains into **Superior Vena Cava (SVC)**.

The lower part of anastomosis: venous blood from lower part of the skin of umbilical region descend to *inferior epigastric vein* and passes to *external iliac vein*. This vein is a tributary of the *common iliac vein* and venous blood passed to **Inferior Venae Cava** (Fig. 6).

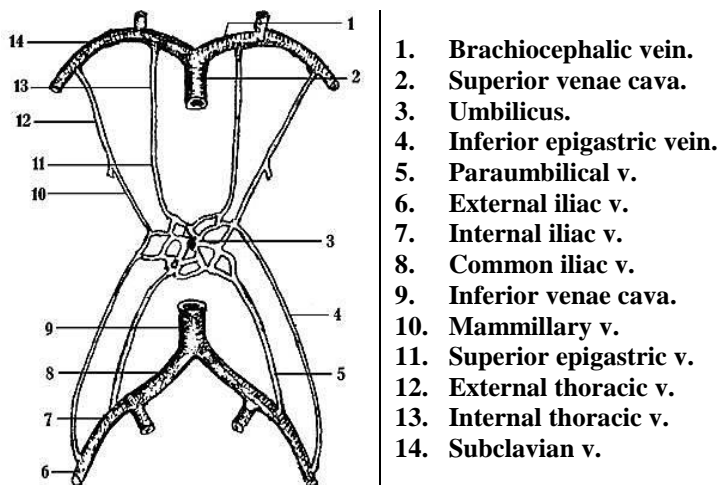


Fig. 6. Diagram of anastomosis around umbilical region

THE HEAD OF MEDUSA

The head of Medusa is formed after dilatation of veins around umbilicus. In *portal hypertension*, as in the case of *cirrhosis* of the liver, the anastomosis becomes congested and forms venous dilatations because of high pressure in paraumbilical veins. This pathology leads to the formation of *Caput medusae* (a head of medusa) on the skin of anterior abdominal wall (Fig. 7). Such dilatation can lead to *esophageal varices* and *anorectal varices*.



Fig.7. Caput medusa

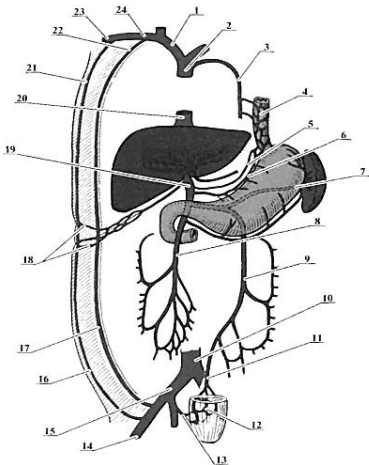
THE CAVA-CAVAL ANASTOMOSIS AROUND UMBILICUS

• **THIS PATHOLOGY DEVELOPS AFTER THROMBOSES OF SUPERFICIAL VEINS OF UMBILICAL REGION EXCEPT V. PARAUMBILICALIS paraumbilical veins!!!**

• The problems are present in tributaries of **Superior and Inferior Vena Cava.**

• venous blood from upper part of umbilicus goes to **v. epigastrica superior** passes to **v. thoracica interna** and abjoints with **subclavian vein** goes to next vessels → **v. brachiocephalica** and stop to **Superior Vena Cava.**

• The venous blood from lower part of anterior abdominal wall passes to **v. epigastrica inferior** to next branch is **external iliac vein (v. iliaca externa)**. This is vein adjoints with common iliac vein (**v. iliaca communis**) and last way to **Inferior Vena Cava** (Fig. 8).



1. Brachiocephalic v.
2. Superior vena cava.
24. Subclavian v.
22. Internal thoracic.
21. Superior epigastric v.
17. inferior epigastric v.
14. external iliac v.
15. common iliac v.
18. paraumbilical v.

Fig. 8. Schema of anastomosis around umbilicus (without paraumbilical vein)

The port- caval anastomosis are resides in abdominal part of the esophagus, in walls of the rectum and posterior wall of the abdominal cavity.

THE PORTO- CAVA-CAVAL ANASTOMOSIS SURROUND ESOPHAGUS

From cervical part of esophagus venous blood drainage to *superior esophageal veins* after that adjoins to *inferior thyroid vein* and goes to *subclavian vein*. Latter venous blood → distributes to *brachiocephalic vein* and abjoins with *Superior Vena Cava* and stops to *right atrium of the heart* (Fig. 9).

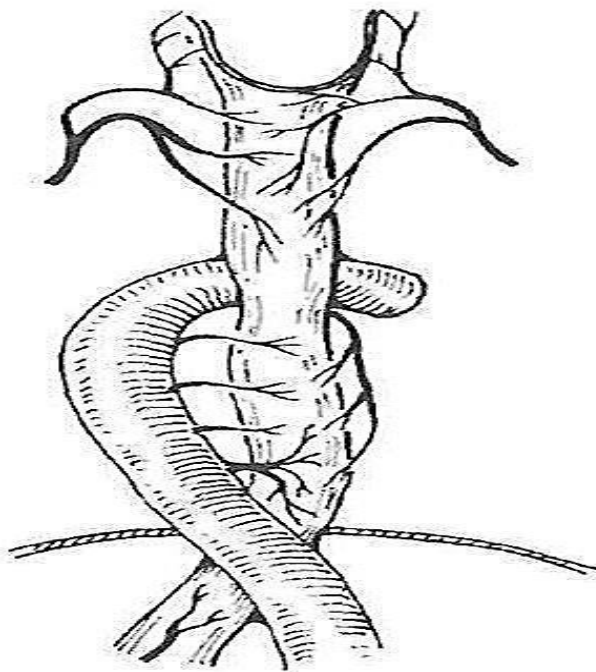
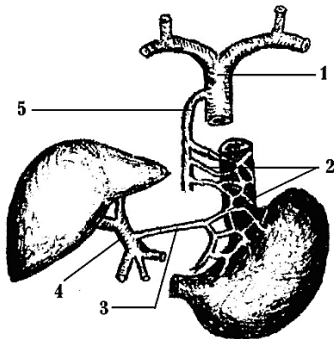


Fig. 9. Blood supply of upper and medial part of esophagus

From thoracic part of esophagus origin medial venous plexus → to posterior intercostal veins → to azygos and haemi-azygos → to IVC.

From abdominal part of esophagus origin *esophageal veins* → to *left gastric vein* → to *portal vein – PV* (Fig. 10).



Blood supply of lower part of esophagus.

1. Superior vena cava.
2. Internal thoracic v.
3. Left gastric v.
4. Portal vein.
5. Inferior thyroid v.

Fig. 10. The scheme of anastomosis of esophagus

Superior esophageal vein adjoins with inferior thyroid.

The venous blood from thoracic part of esophagus passes to posterior intercostal to azygos and haemiazygos veins.

Clinical application. If present hypertension in portal vein system outflow of blood from the left gastric vein becomes more difficult and the load on the venous plexus of the esophagus increases, which leads to their varicose expansion. Varicose nodes often protrude into the lumen of the esophagus, cardiac section of the stomach and can be injured when passing insufficiently chewed or rough food through the esophagus, which leads to profuse esophageal-gastric bleeding and death.

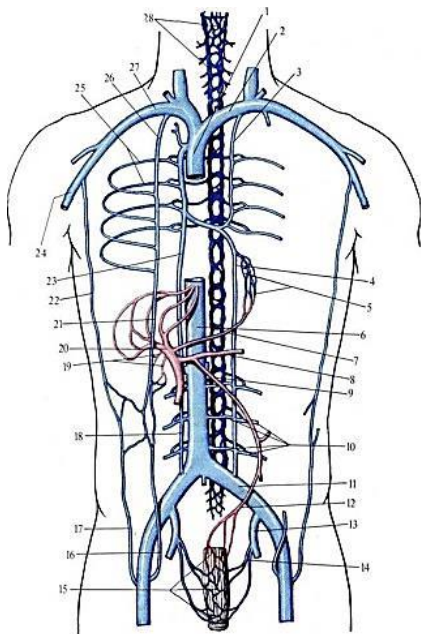
THE CAVA-CAVAL ANASTOMOSIS AROUND SPINAL CORD

VENOUS DRAINAGE FROM CERVICAL PART OF SPINAL CORD: The **venous vertebral plexus** (anterior and posterior) surrounded spinal cord and venous blood distributed → *to spinal veins* → after goes to *vertebral veins* → to *brachiocephalic vein* → to **Superior Vena Cava**.

VENOUS DRAINAGE FROM THORACIC PART: The **venous vertebral plexus** resides in thoracic part of spinal cord. A venous blood goes to → *the nine right lower veins* are forms the *posterior intercostal veins* → to *azygos vein* → to **Superior Vena Cava**.

VENOUS DRAINAGE FROM LUMBAR PART: The venous blood goes to venous vertebral plexus on lumbar part of the spinal cord **and go to the left ascending lumbar veins** joints similarly with *azygos veins* opposite side and accessory *haemi-azygos vein* go to **Inferior Vena Cava**.

VENOUS DRAINAGE FROM SACRAL PART OF SPINAL CORD: From venous sacral plexus a venous blood distributed → to lumbar veins → to azygos and hemi-azygos → to IVC (Fig. 11).



1. SVC.
2. Brachiocephalic vein.
3. Internal thoracic v.
4. Hemiazygos v.
5. Left gastric vein.
6. Inferior vena cava.
7. Lumbar venous plexus of spinal cord
8. Splenic vein
9. Inferior mesocolic vein
10. Lumbar veins
11. Common iliac vein
12. Superior rectal vein
13. Internal iliac vein
14. Medial rectal veins
15. Rectal venous plexus
16. Inferior epigastric vein
17. Superficial epigastric vein
18. Ascending lumbar veins
19. Paraumbilical vein
20. Portal vein
21. Superior epigastric v.
22. Thoracoepigastric v.
23. Azygos v.
24. Axillary v.
25. Anterior intercostal v.
26. Internal thoracic
27. Subclavian v.
28. Cervical spinal plexus

Fig. 11. The scheme of anastomosis

THE PORTO-CAVAL ANASTONOSIS NEAR OF THE RECTUM

The *rectal venous plexus* surrounds the submucosal layer of rectum. From superior part of rectum arises a *superior rectal veins* → to *inferior mesocolic vein* and adjoin to *portal vein (PV)*.

From medial part of rectum begins *medial rectal vein* → to *internal iliac vein* → to *Inferior Vena Cava*.

From inferior part of rectum begins *inferior rectal vein* → and connects with *internal pudendal vein* to *internal iliac vein* → to *IVC* (Fig. 12).

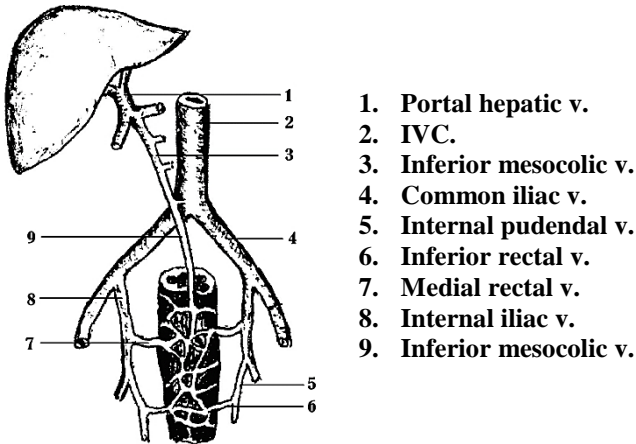


Fig. 12. A venous anastomosis around rectum.

PORTO-CAVAL ANASTOMOSIS IN ASCENDING AND DESCENDING COLON

A venous blood from ascending colon distribute to **right colic vein** → to **superior mesenteric vein** → and adjoins with portal vein → **Portal Vein**.

The second venous drainage from ascending colon venous blood → to **lumbar vein** → to **Inferior Vena Cava**.

From descending colon arises from left colic vein → to **inferior mesenteric vein** → to portal vein PV and **from lumbar veins to IVC** (Fig. 13).

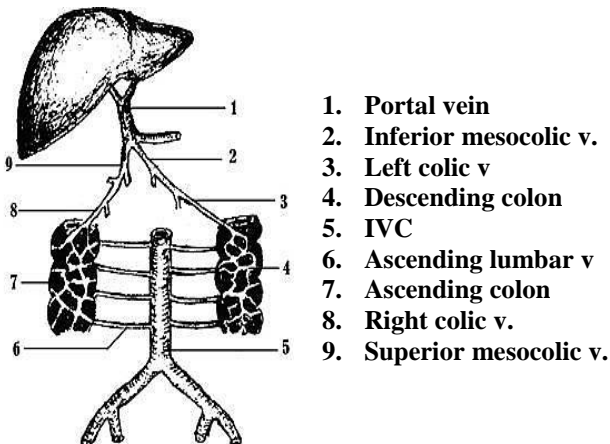


Fig. 13. Venouse anastomosis around ascending and descending colon

A Port-caval anastomoses are normally poorly developed. They significantly expand with impaired blood outflow through the portal vein or with difficulties in blood flow through the intraorganic vessels of the liver. In these cases, port-caval anastomoses provide a "discharge" of blood from the portal vein system into the system of the superior or inferior vena cava.

A knowledge about distributions of the venous anastomosis so important and had a big clinical application for many specialists (for surgeons, therapists, proctologists et al).

Schematically you can see human body likes a cuboidal- in shape with 6 walls are (anterior, superior, 2 laterals posterior and inferior). A big roots are SVC and IVC resides in top and bottom of the human body. The cava-caval anastomoses are present on anterior wall, the porto- cava- caval anastomosis on posterior wall of the human body and porto- caval anastomoses are resides on inferior and superior walls of the human body (Fig. 14).

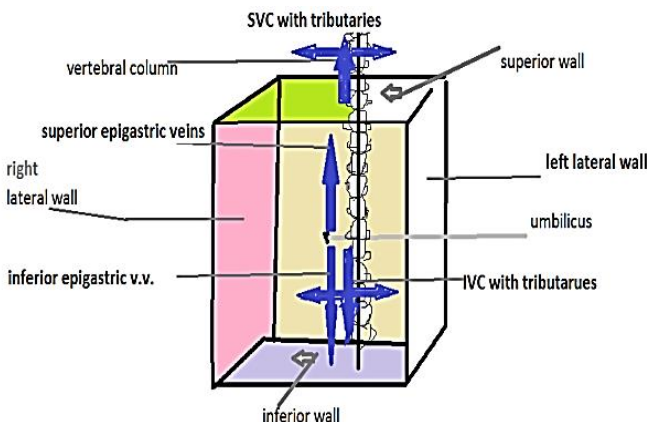


Fig. 14. Schema of the human body with venous roots

THE FETAL CIRCULATION

From placenta the oxygenated blood from mother's body goes along *paraumbilical veins* to umbilical ring to portal vein – to liver. This blood passes through *umbilical vein* (and takes accessory portion of erythrocytes with O₂ from liver) and distributes to **Inferior Vena Cava (IVC)**. This is vessel adjoined with right atrium of heart.

In the heart present communication between of the right and left atriums – the *foramen ovale*. The venous blood directly goes from right atrium through oval foramen to left atrium when blood is mixed.

The Venouse Anastomoses. The Fetal Circulation

The good oxygenated blood distributed to aortae passes through *arteriosus duct* (3 big branches *brachiocephalic trunk, left common carotid and subclavian*) to *top of the fetal body (to neck and head region)*.

After gas change from organs drainage dizoxigeneted blood to **Superior Vena Cava (SVC)** to right atrium after that to right ventricle and to pulmonary trunk (**but lungs are closed!**). The mixed blood goes to Batallov's duct (**arteriosus duct**) to subclavian artery to organs of the **lower part of the fetal body** (Fig. 15).

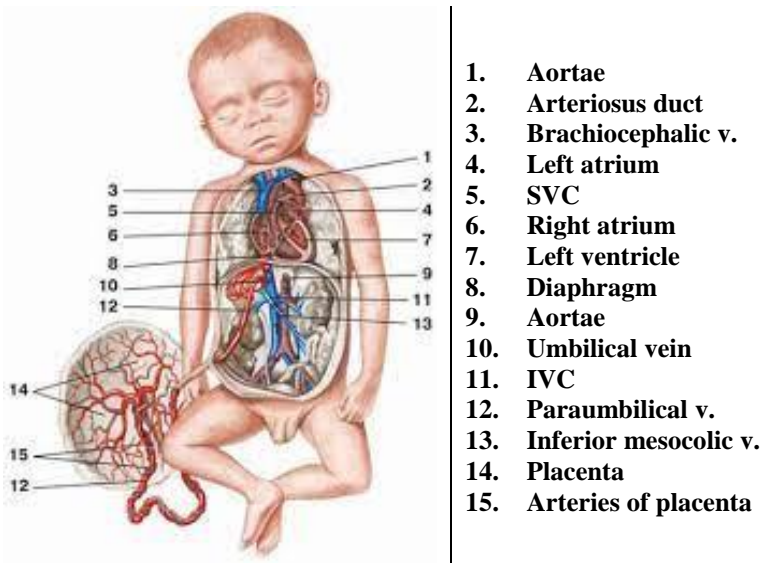


Fig. 15. The fetal circulation

After gas changes in organs total dioxygen blood goes to inferior vena cava IVC along paraumbilican artery inside of lig. teres hepatis after that distributes to placenta for new gas change.

- **AFTER BIRTH** (**paraumbilical artery** becomes **round lig.** of the liver, **the Batallov's duct** becomes **lig. arteriosum**, **foramen oval** becomes **fossa ovalis**).

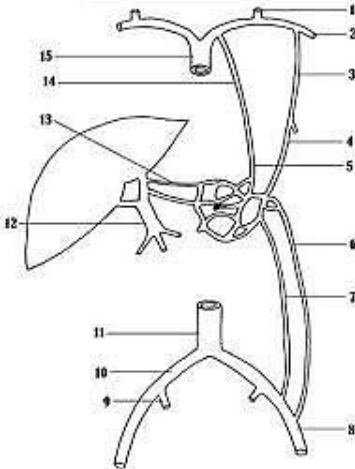
TRAINING TASKS

INDEPENDENT WORK № 1

In ultrasound examination a double entanglement of the umbilical cord of the neck was revealed. What are vessels can be pinched in this case?

- A. Vena portae.
- B. Umbilical vein.
- C. IVC.
- D. 2 umbilical arteries and 1 Umbilical vein.
- E. Paraumbilical vein.

INDEPENDENT WORK № 2



Look on the picture and write a correct options:

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.

Options: SVC, IVC, brachiocephalic vein, superior epigastric vein, inferior epigastric vein, PV, common iliac vein, internal iliac vein, external iliac vein, subclavian vein, paraumbilical veins, internal thoracic vein.

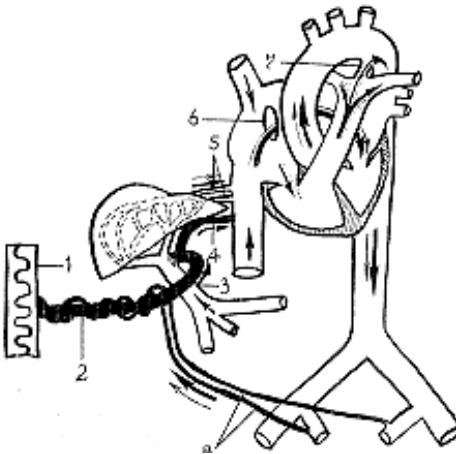
INDEPENDENT WORK № 3

In during childbirth in newborn was found tight umbilical cord around the neck. What are vessels can be pinched in this case?

- A. 2 umbilical arteries and 1 Umbilical vein.
- B. Paraumbilical veins.
- C. IVC.
- D. Vena portae.
- E. Umbilical vein.

The Venose Anastomoses. The Fetal Circulation

INDEPENDENT WORK № 4



Look on the picture and write a correct answers:

- 1.
- 2.
- 4.
- 5.
- 6.
- 7.
- 8.

Options: placenta, paraumbilical artery, aortae, arteriosus duct, SVC, IVC, foramen ovale, umbilical veins.

INDEPENDENT WORK № 5

At 36 weeks pregnant after ultrasound examination was found closed oval foramen, this leads to impaired circulation and fetal death. In which vessels there was a hemodynamic disorder?

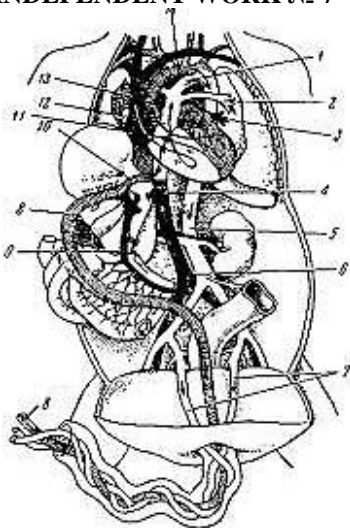
- A. Aorta.
- B. Paraumbilical vein.
- C. IVC.
- D. Vena portae.
- E. Umbilical vein.

INDEPENDENT WORK № 6

Where is present oxygenation of the fetal blood by oxygen in during pregnancy?

- A. In placenta
- B. In mother's lung's.
- C. In fetal's lungs.
- D. In fetal liver.
- E. In vessels of the umbilical chord.

INDEPENDENT WORK № 7



Look on the picture and write a correct options:

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.
- 11.
- 12.

Options: IVC, superior epigastric vein, brachiocephalic vein, inferior epigastric vein, PV, common iliac vein, internal iliac vein, external iliac vein, subclavian vein, paraumbilical veins, internal thoracic vein, SVC, umbilical artery, aorta.

INDEPENDENT WORK № 8

In during childbirth less loops of the umbilical cord of the newborn. Constriction of which kind of vessels may in this case?

- A. Ductus arteriosus.
- B. IVC and SVC.
- C. 2 Paraumbilical veins and 1 umbilical artery.
- D. Vena portae.
- E. 2 umbilical arteries and 1 Umbilical vein.

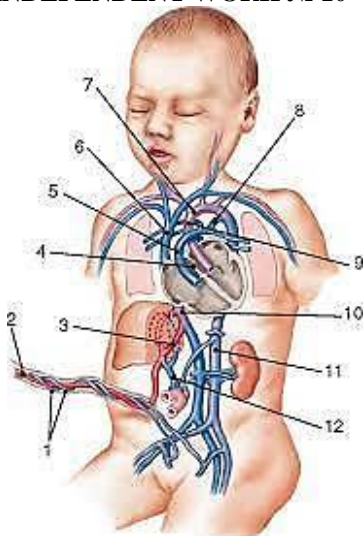
INDEPENDENT WORK № 9

A man 50-years old has chronical alcohol hepatitis. He complains of intermittent bloody vomiting caused by portal hypertension. Which veins are damaged by chronic disease?

- A. V.V.easophagalis
- B. Vena portae
- C. Vena gastrica dextra.
- D. v. azygos and hemiazygos.
- E. IVC.

The Venose Anastomoses. The Fetal Circulation

INDEPENDENT WORK № 10



Look on the picture and write a correct options:

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.
- 11.
- 12.

Options: IVC, superior epigastric vein, brachiocephalic vein, inferior epigastric vein, PV, common iliac vein, internal iliac vein, external iliac vein, subclavian vein, paraumbilical veins, internal thoracic vein, SVC, umbilical artery, aorta.

INDEPENDENT WORK № 11

In case of massive bleeding from the uterus after childbirth, which vessels are ligated to stop bleeding completely?

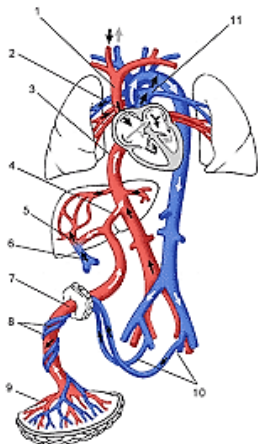
- A. Internal iliac artery of both sides.
- B. Left common iliac artery.
- C. Uterine artery.
- D. External iliac artery.
- E. A. ovarica.

INDEPENDENT WORK № 12

An external examination of the anterior abdominal wall in a 65-year-old man revealed enlargement of the superficial veins of the umbilical region. Which veins are affected?

- A. VV.easophagalis.
- B. SVC.
- C. Vena gastrica dextra.
- D. Vena portae.
- E. IVC.

INDEPENDENT WORK № 13



To write a the correct options

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.

Options: IVC, superior epigastric vein, brachiocephalic vein, inferior epigastric vein, PV, common iliac vein, internal iliac vein, external iliac vein, subclavian vein, paraumbilical veins, internal thoracic vein, SVC, umbilical artery, aorta.

INDEPENDENT WORK № 14

The patient 40-year-old man complains of pain and burning sensation in the anal area, aggravated after straining. In during examining the rectum doctor can see an oval-shaped protrusion with signs of inflammation was found. Disorders of outflow in which veins reduced to this condition?

- A. VV. rectalis inferior.
- B. Vena portae.
- C. IVC.
- D. Internal pudendal vein.
- E. External iliac vein.

INDEPENDENT WORK № 15

In during esophagostomy (examination of the mucous membrane of the esophagus) on the anterior abdominal region revealed a significant expansion of the veins of the submucosa. How can you explain the expansion of these veins?

- A. Hypertension in portal system.
- B. Dilatation of the PV.
- C. Atherosclerosis of the vessels.
- D. Hypertonia.
- E. External iliac vein.

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