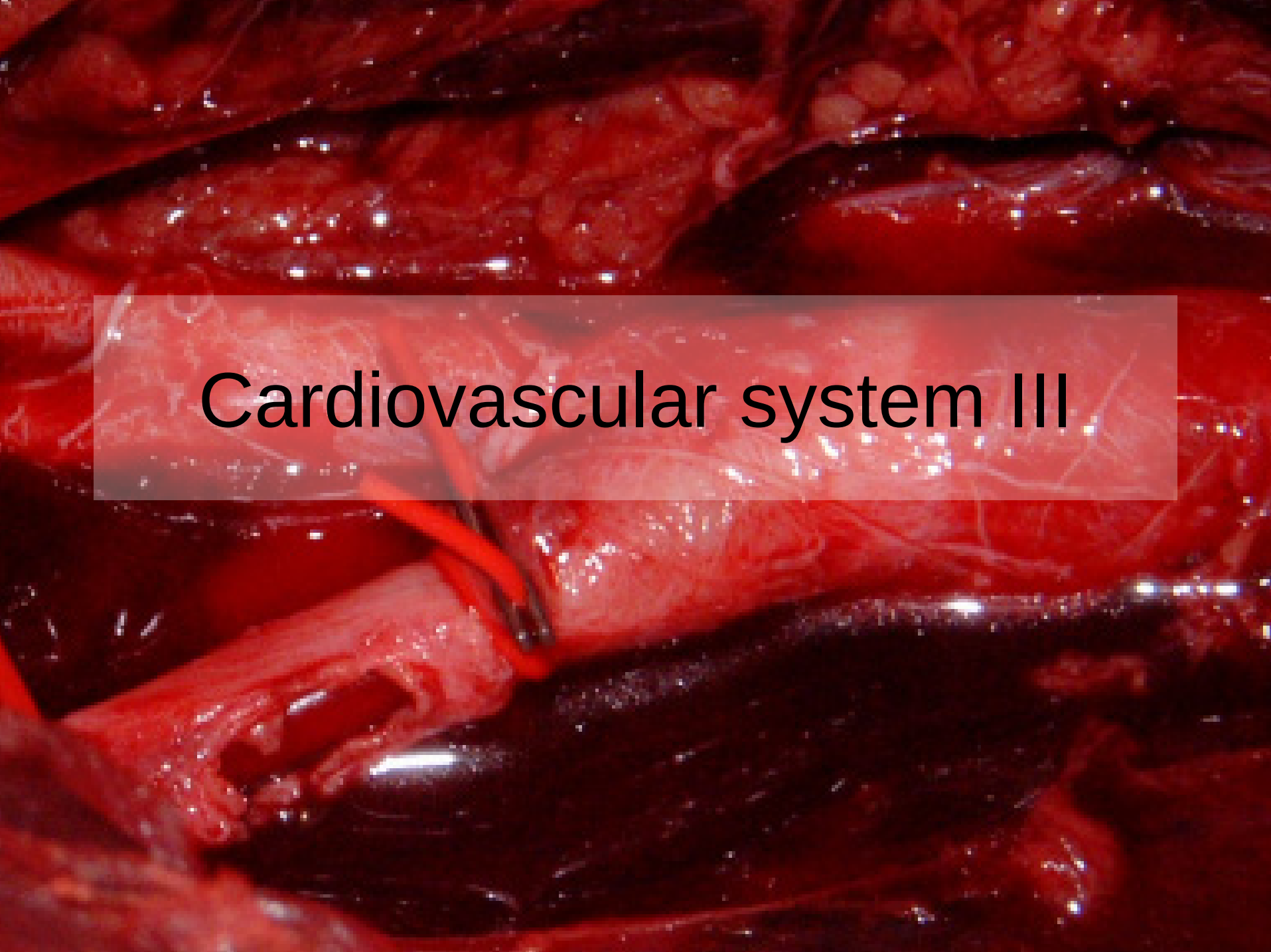
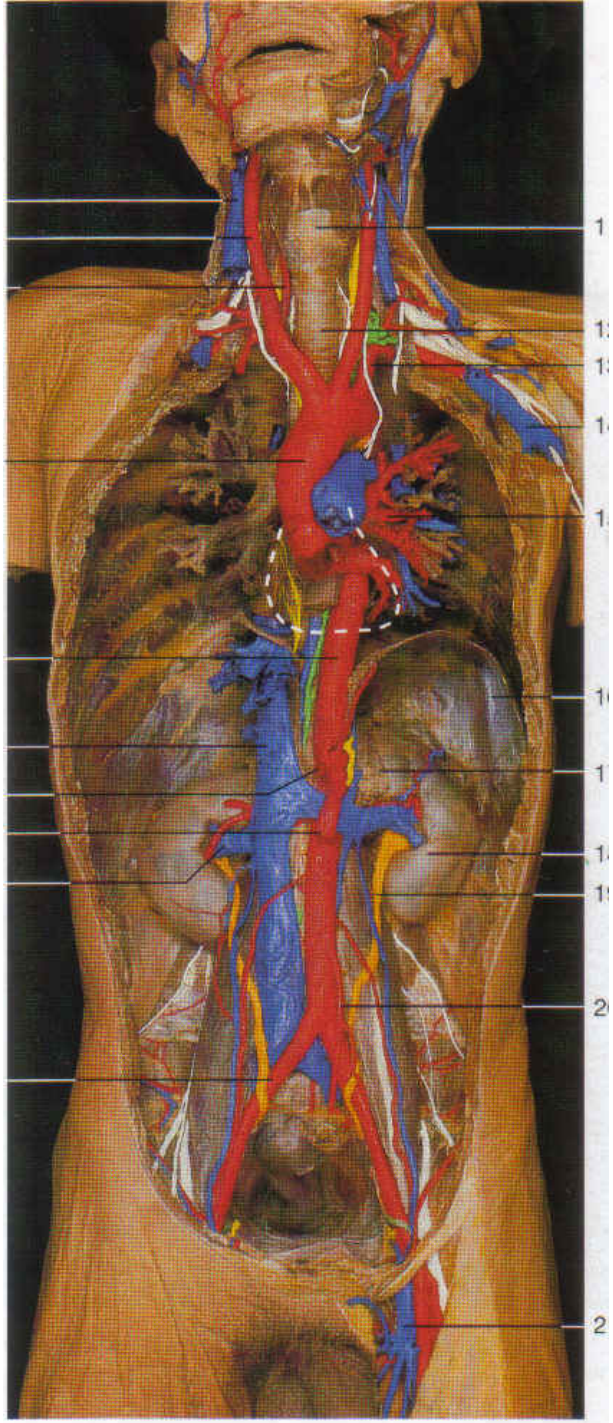


Cardiovascular system III

Arteries vs. Veins

- Vessels-pipes, carries blood through out the body
- Arteries carry blood away from the ventricles of the heart
- Arteries carry O_2 rich blood except the pulmonary arteries

- Vein carry blood to the atria of the heart
- Veins carry deoxygenated blood except the pulmonary veins



Circuits of the Vascular System

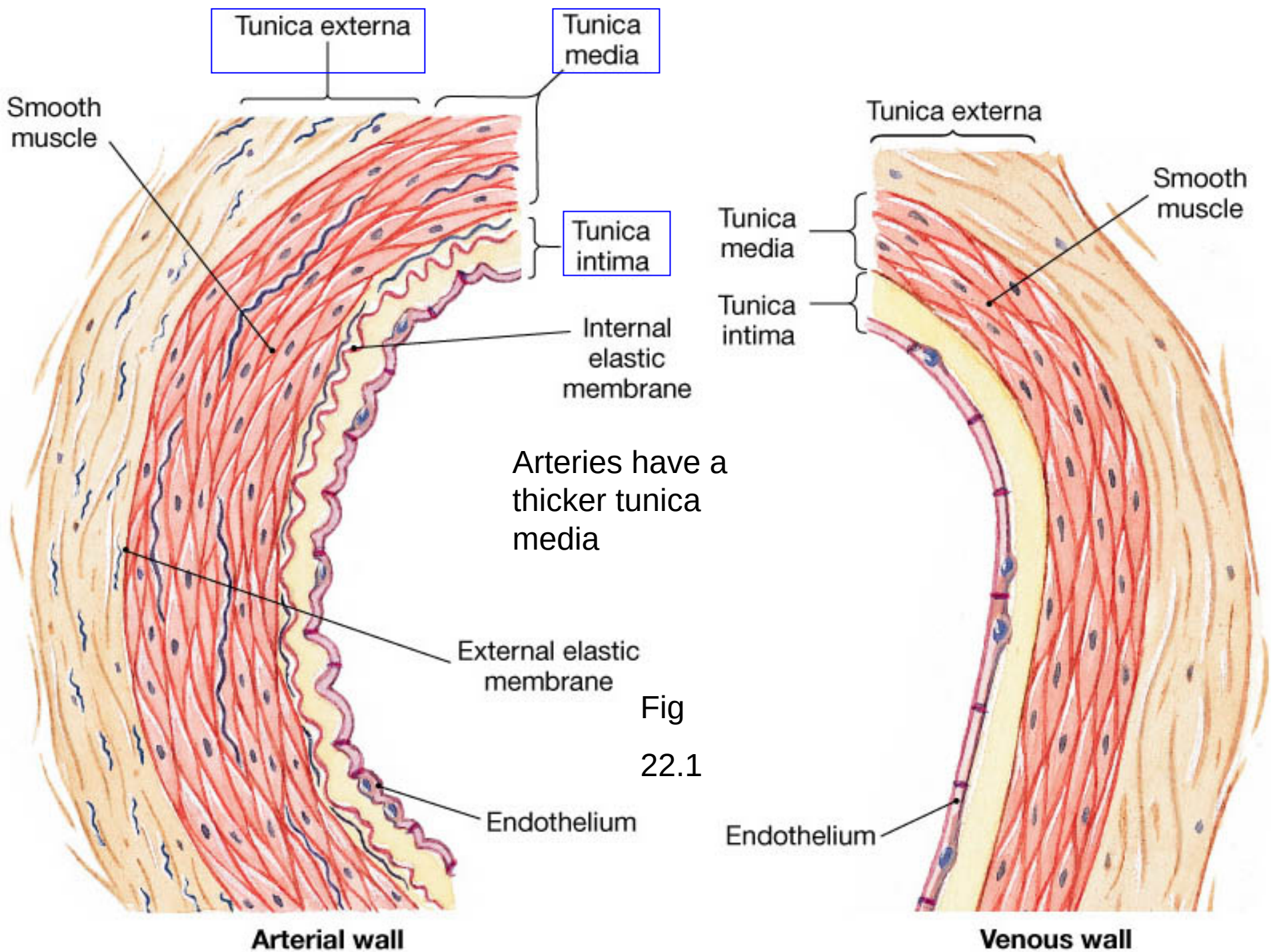
- Pulmonary Circuit- oxygenation of blood
- From the Pulmonary semilunar valve→Through the lungs→to the entrance of the left atrium
- Systemic Circuit- oxygenation of tissue
- From the aortic semilunar valve→through the body→to the entrance of the right atrium

Tunics (Layers) of vessel Walls

- Tunica interna
  Deepest layer (contacts blood)
  Endothelial lining + basement membrane
  Arteries have elastic layer

- Tunica media
- Middle layer
  Layers of smooth muscle
  Arteries have elastic fibers

- Tunica Externa (adventitia)
  Superfical layer
  Connect tissue layers-attaches to each other and other organs
  Both have elastic and collagen fibers



Arteries have a thicker tunica media

Fig 22.1

Elastic Arteries

conducting arteries (move larger amount of blood)

large diameter (2.5cm)

walls proportionally not as thick (relative to diameter)

Tunica media-

few smooth muscle fibers

high density of elastic fibers (for elastic recoil)

undergo large pressure changes (ventricular systole/diastole)

pulmonary artery, aorta, and major branches are examples

Muscular Arteries

distribution arteries
relatively small diameter (0.4cm)
thicker tunica media (relative to diameter) than elastic artery
Tunica media- thicker (compared to elastic arteries)
high density of smooth muscle fibers
less elastic fibers

- UNDER GO DIAMETER CHANGES due to ANS (autonomic nervous system) input for blood flow regulation to organs.

- Arteries in neck, and appendages are examples

arterioles

small diameter (30μm)

poorly defined tunica externa

incomplete tunica media (scattered smooth muscle)

Control blood from between arteries ad capillaries

1 arteriole leads to dozens of cappillaries

Veins: Mechanisms to move blood

- Blood pressure too low in veins to move blood efficiently
-
- Three Mechanisms:
-
- 1. Valves
- -found in limbs
- -semilunar-type valves (similar to heart)
- -one-way (no backflow in healthy veins)
- -moves bolus of blood up section-by-section
- -folding of tunica interna

- 2. Skeletal Muscle Pump
- -veins located between muscles
- -pressure on vessel walls from contracted muscles
- -“pushes” blood through
- -Not found in larger vessels of anterior cavity
-
- 3. Thoracoabdominal Pump
- -Breathing changes pressure within thoracic and abdominal cavities
- -As one cavity pressure increases, the other cavity pressure decreases
- -“Push-pull” blood through
- -Only found in larger vessels of anterior cavity

Venous valves Skeletal muscle pump-

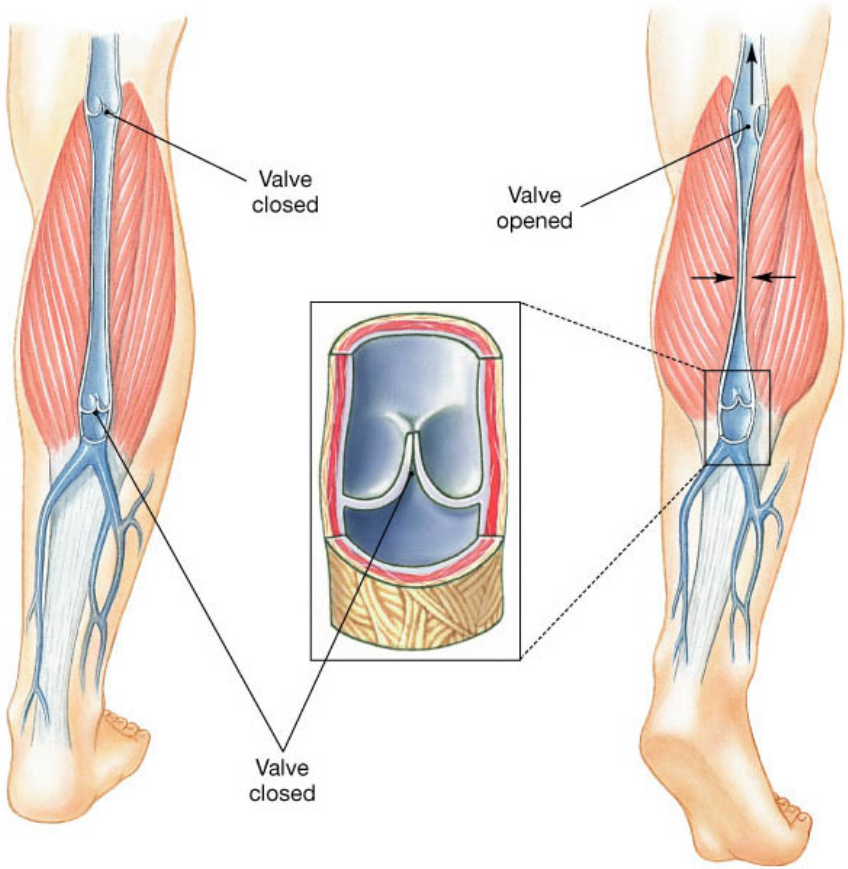


Fig 22.6

- Venules collect blood from capillaries (20µm)
- Medium sized veins (2-9µm)
- Large veins (>9mm)

Arteries vs Veins

Features	Arteries	Veins
General appearance	usually round, no valves	usually flattered,valves
Tunica Interna	rippled	smooth
Internal elastic membrane.	Present	Absent
Tunica Media	Thick, has SM & elastic membrane	Thin has SM & collagen fiber
External elastic membrane.	Present	absent
Tunica Externa	Elastic, Collagen fibers	Elastic collagen fibers + Muscle fibers.

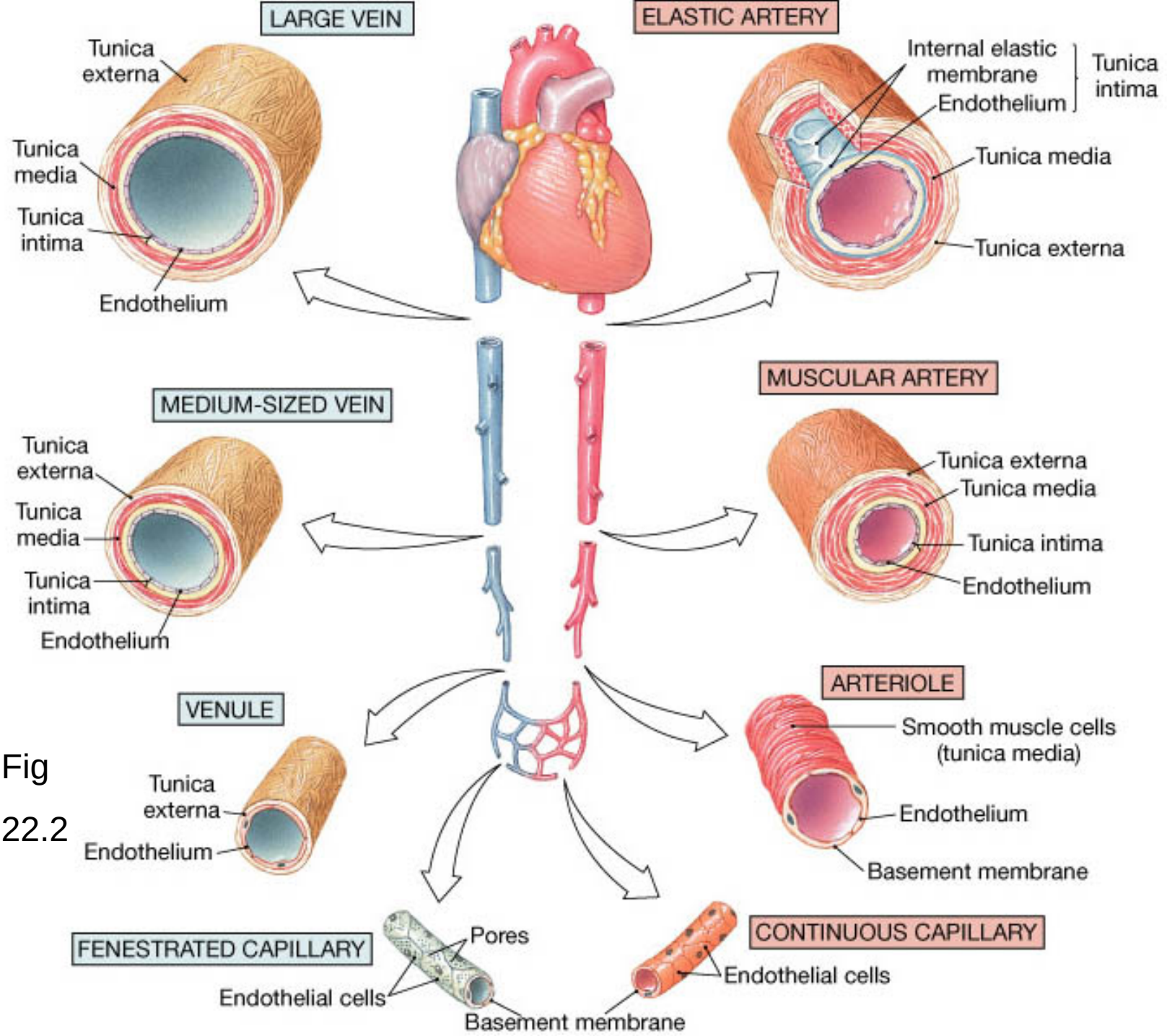
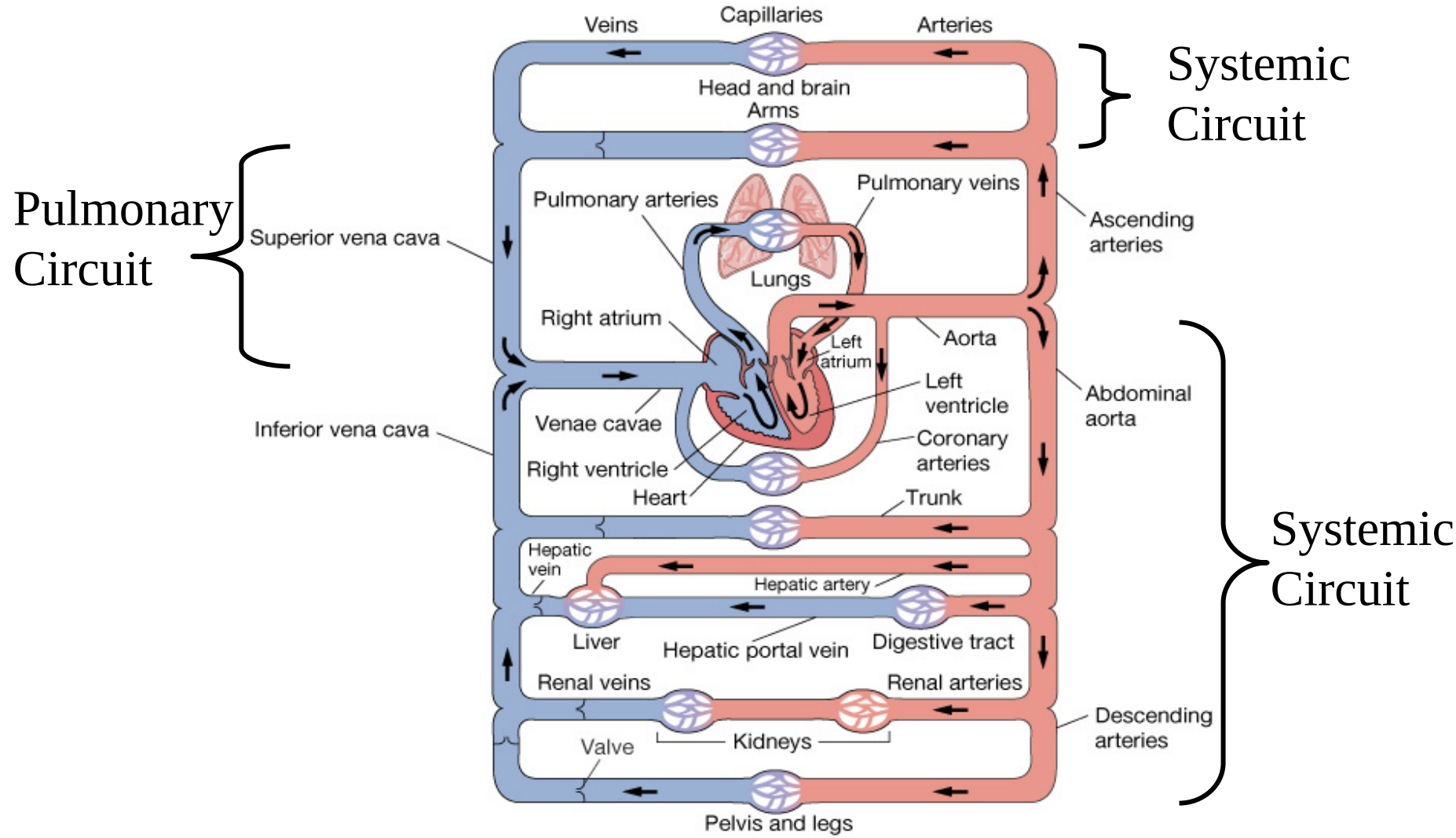

LARGE VEIN
Tunica externa
Tunica media
Tunica intima
Endothelium
ELASTIC ARTERY
Internal elastic membrane
Endothelium
Tunica intima
Tunica media
Tunica externa
MEDIUM-SIZED VEIN
Tunica externa
Tunica media
Tunica intima
Endothelium
MUSCULAR ARTERY
Tunica externa
Tunica media
Tunica intima
Endothelium
VENULE
Tunica externa
Endothelium
ARTERIOLE
Smooth muscle cells (tunica media)
Endothelium
Basement membrane
FENESTRATED CAPILLARY
Pores
Endothelial cells
Basement membrane
CONTINUOUS CAPILLARY
Endothelial cells

Fig 22.2

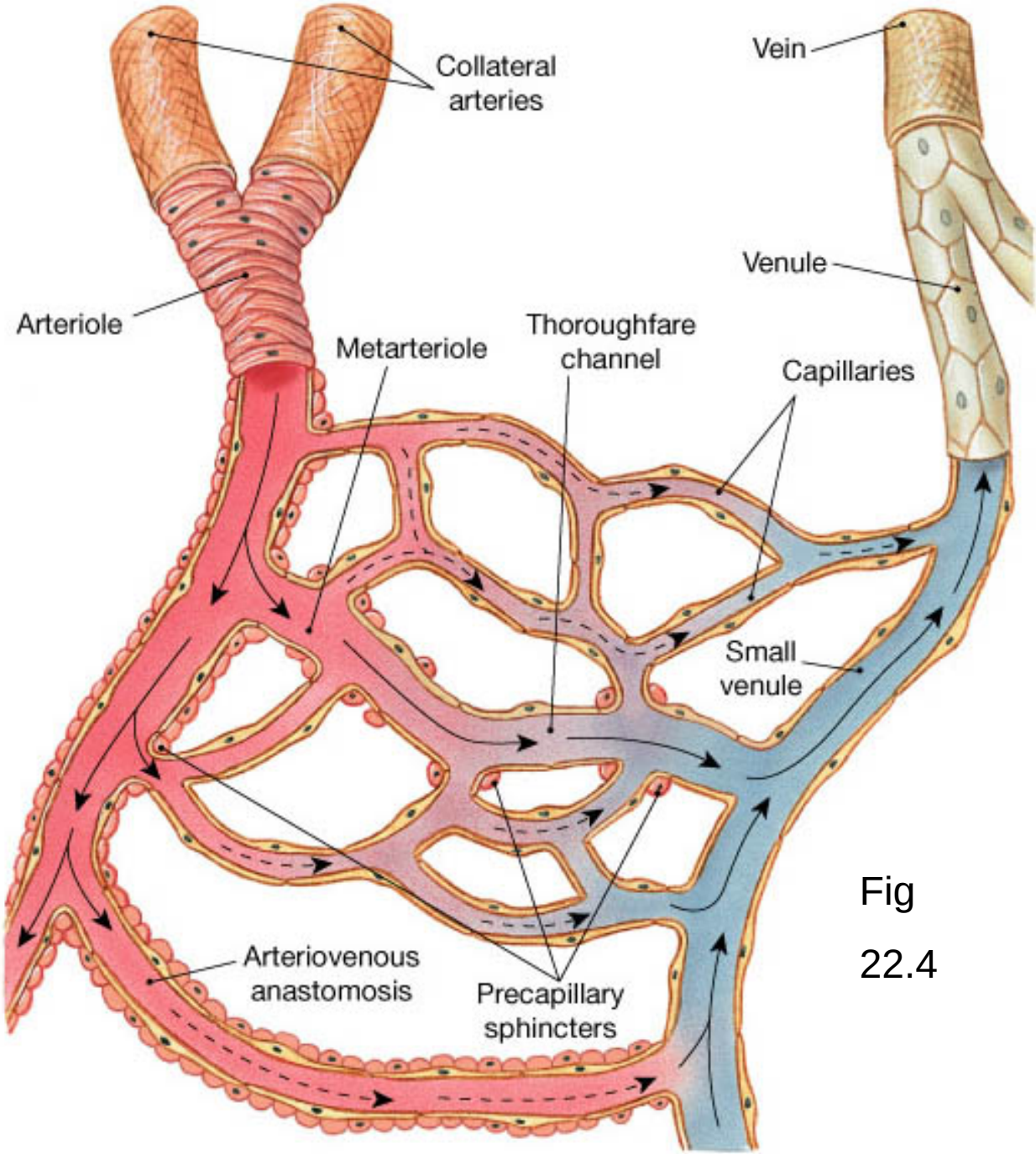
The Circulatory system is a "closed circulation"



Capillaries

- Exchange surface between the cardiovascular system and tissues
- Plasma diffuses out of the capillaries into the tissues carrying gases, nutrients hormones etc

  small diameter (8µm), rbc diameter =7.7µm
- Most capillaries are arranged into capillary beds
- Thinness allows for exchange of material between the blood and tissues



(a) Capillary bed

Fig 22.4

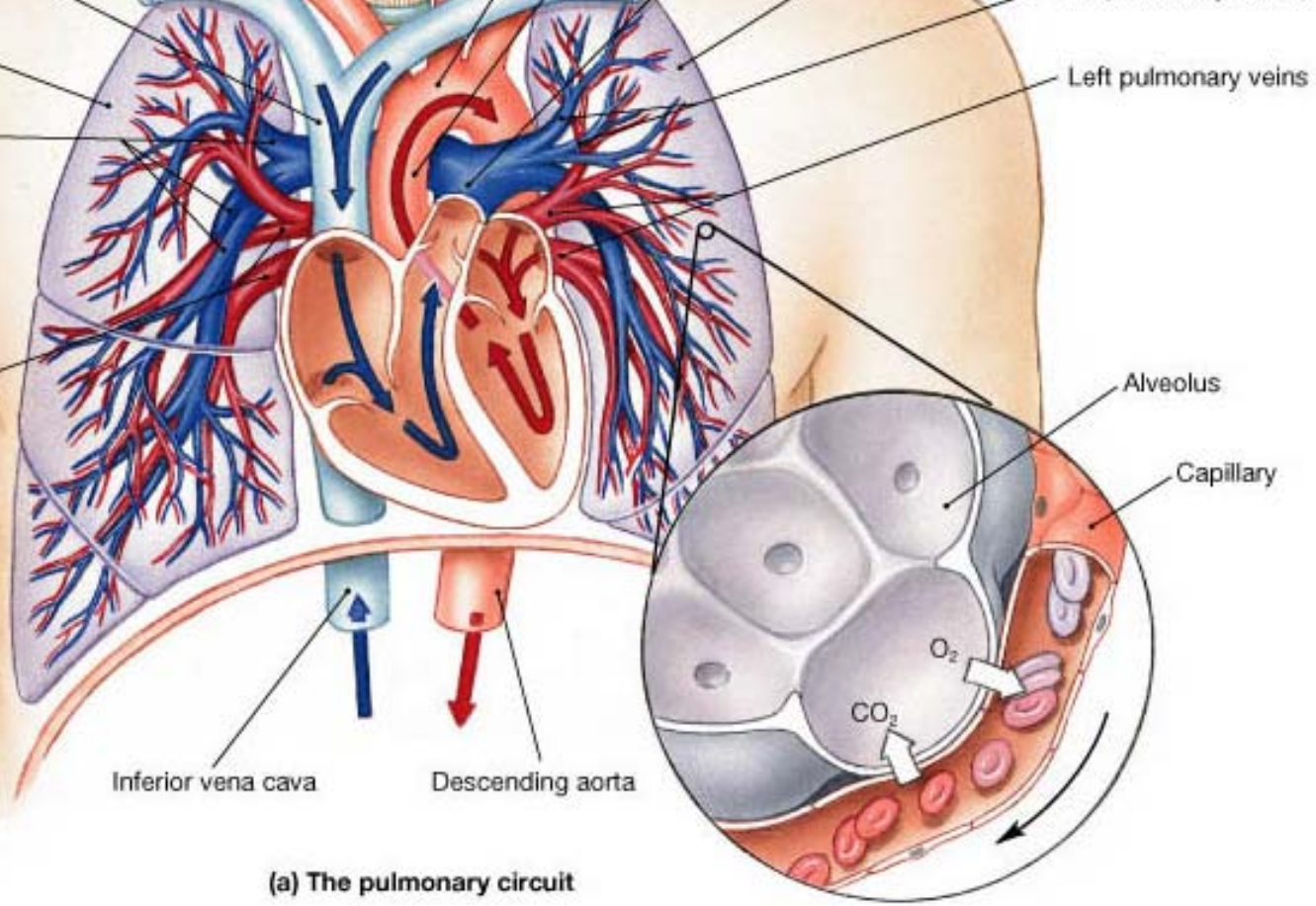
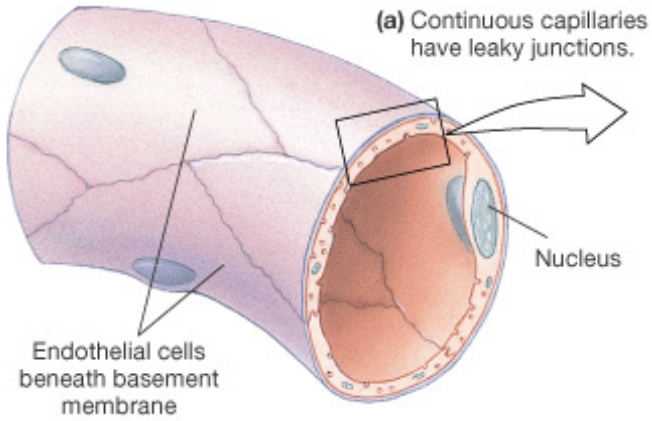
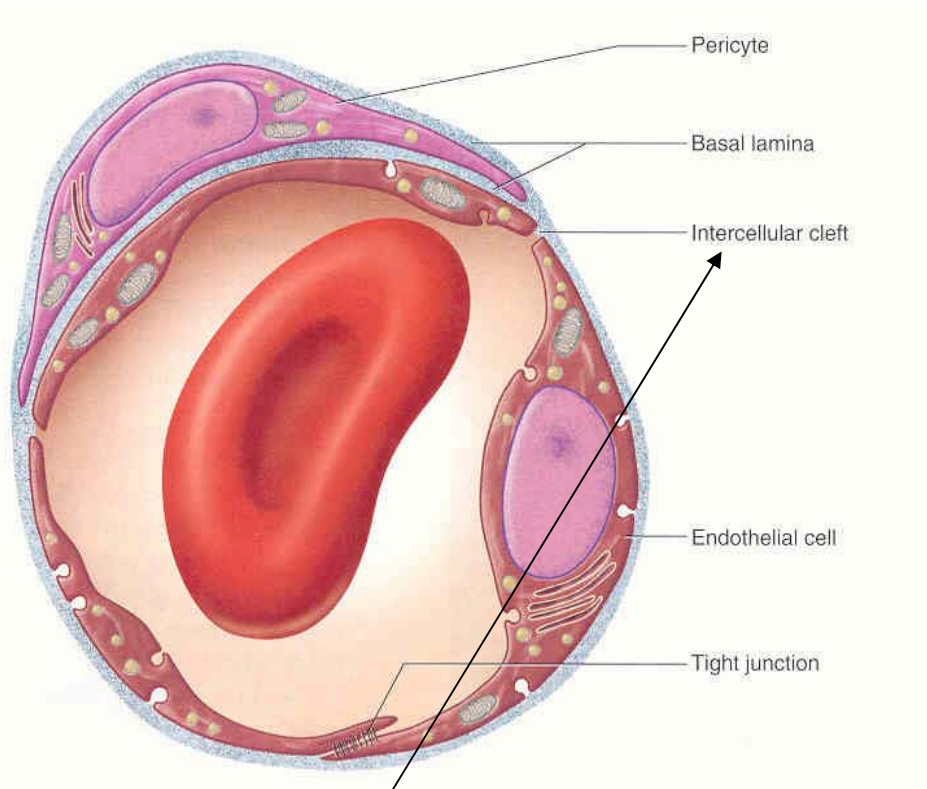

Left pulmonary veins
Alveolus
Capillary
O_2
CO_2
Inferior vena cava
Descending aorta
(a) The pulmonary circuit

Fig 22.9

3 Types of Capillary Beds





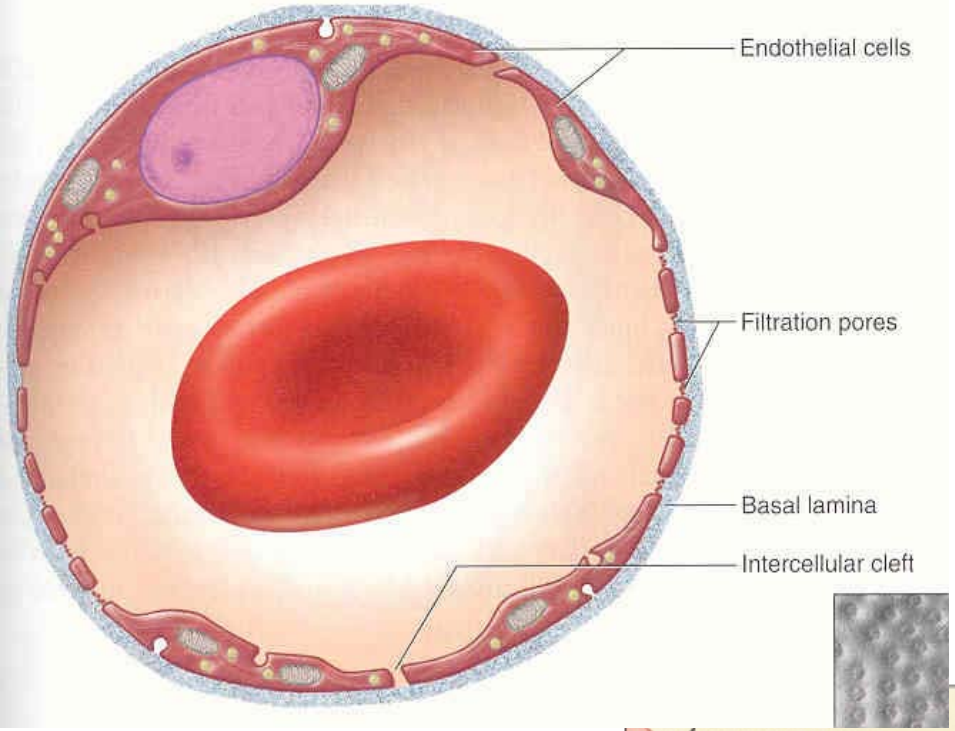
1. Continuous Capillary Bed

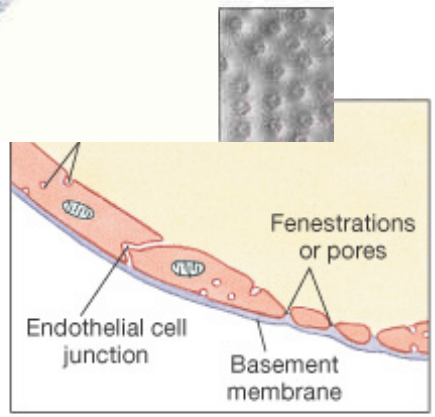
- most common type in the body.
- have tight junctions & desmosomes
- ‘leaky’ capillaries

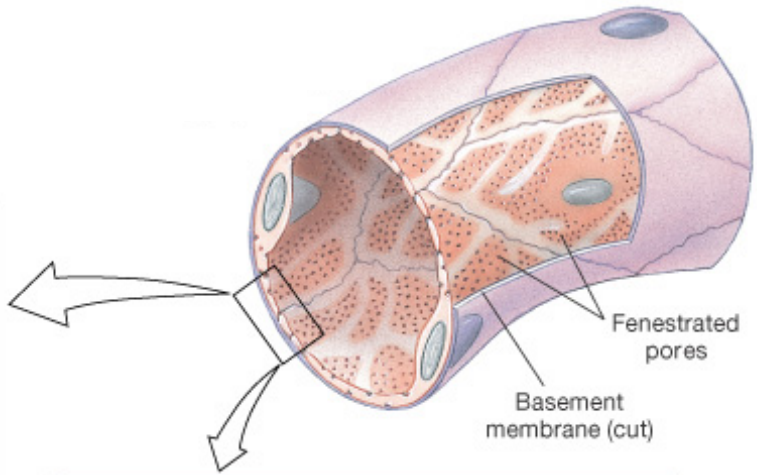
2. Fenestrated Capillary Bed

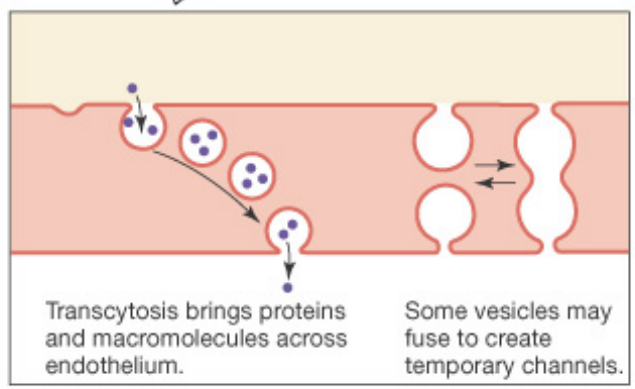
- have ‘pores’ called *fenestrations.*

- more ‘leaky’ than continuous.

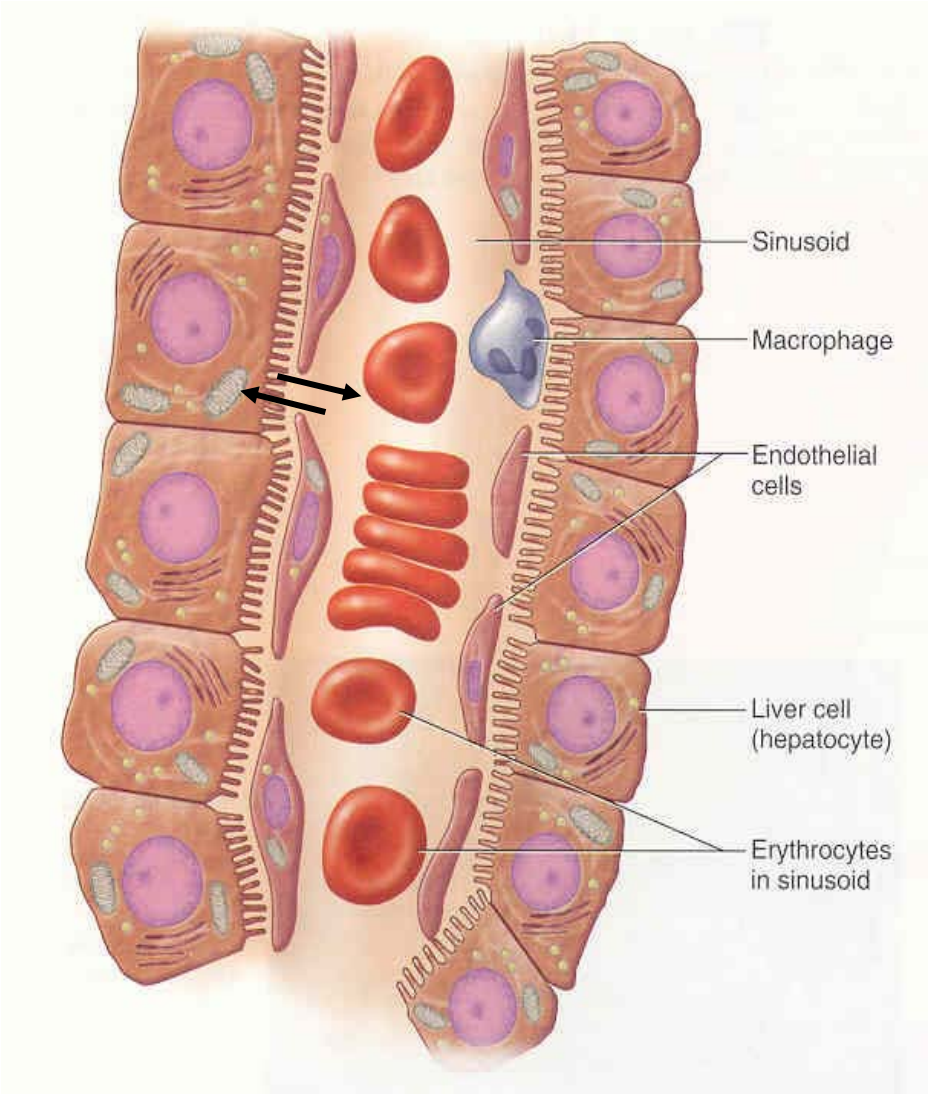








- specific locations in body:
  kidney, capillaries of endocrine organs, synovial joints.



3. Sinusoidal Capillary Bed

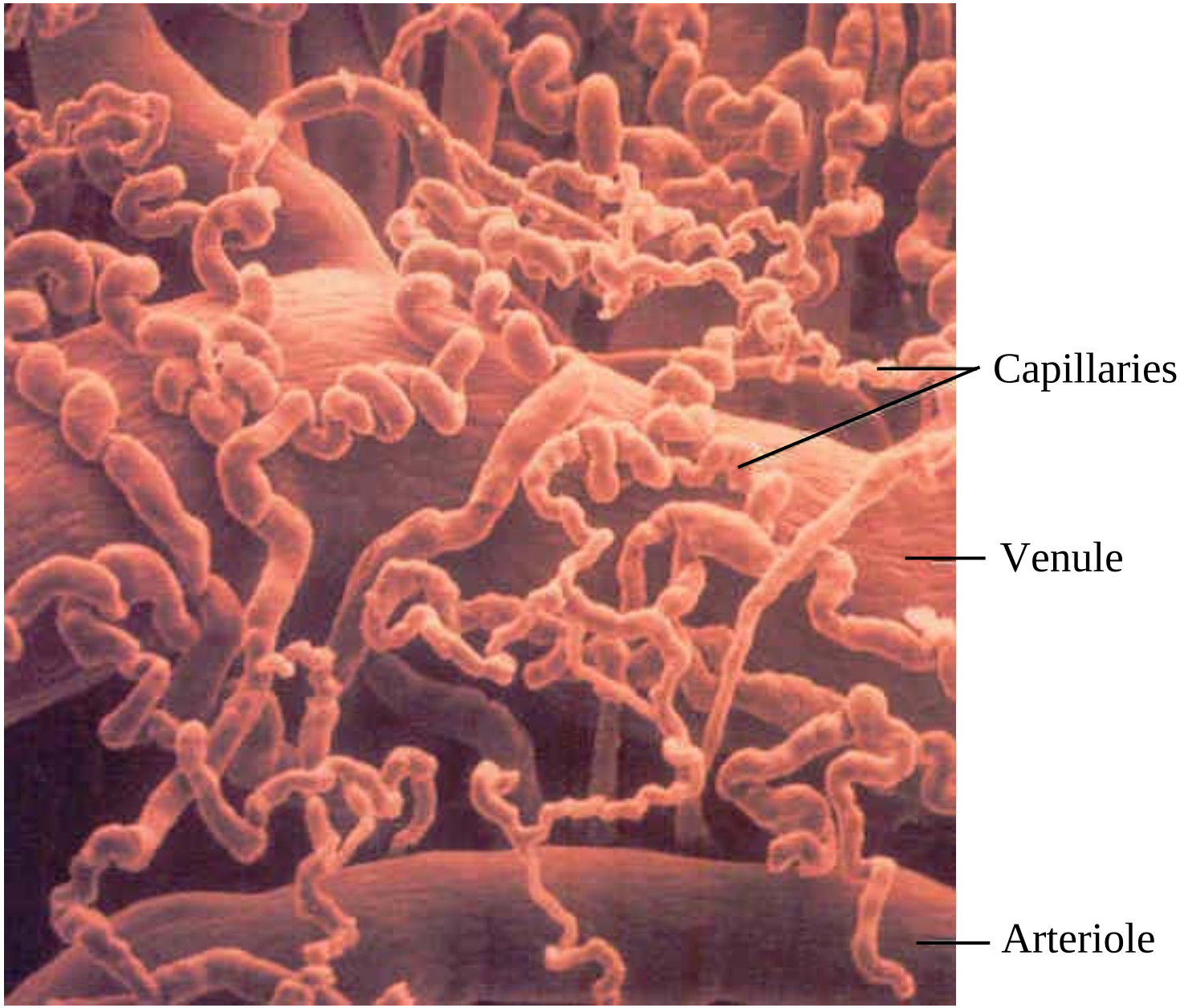
- Largest pores of capillaries.

- ‘leakiest’ capillary bed.

- high degree of exchange.

- highly convoluted (twisting).

- least common in body:
  e.g., liver and spleen.


Capillaries
Venule
Arteriole

Movement across a capillary

- Diffusion (based on concentration gradient)
  - Capillary endothelial cells
  - Gaps between cells
  - Thru pores
- Endo/exocytosis across the endothelial cells

Heart→Arteries(Elastic Arteries)→Muscular Arteries)→Arterioles→Capallaries→Venules →Veins→back to heart.

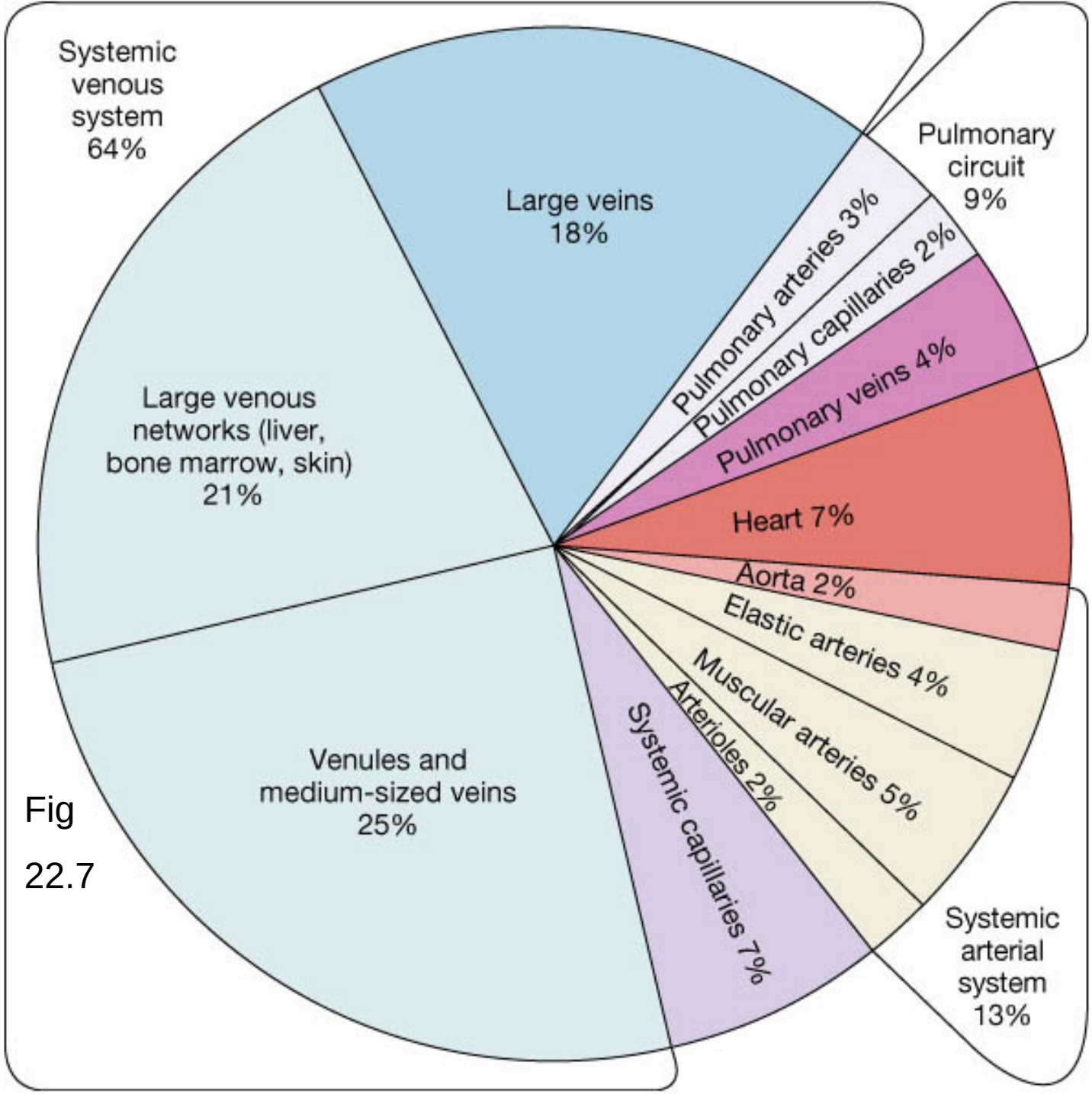
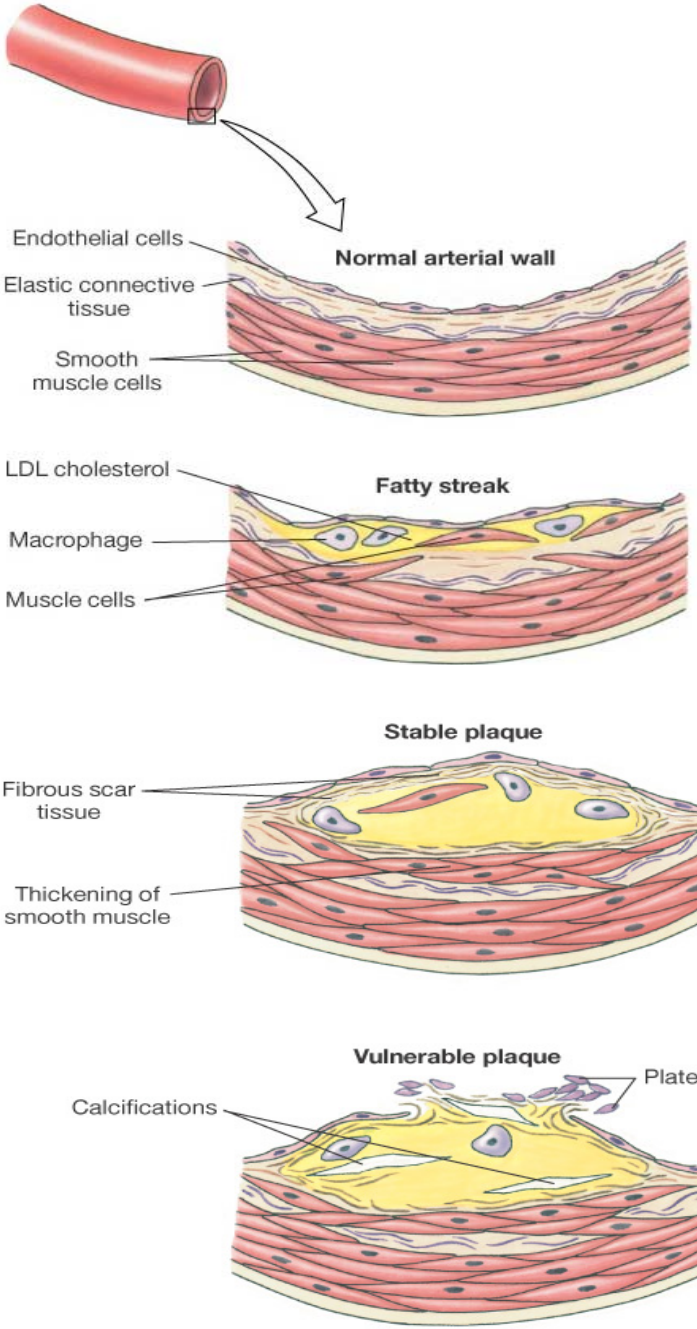

Systemic venous system 64%
Large veins 18%
Large venous networks (liver, bone marrow, skin) 21%
Venules and medium-sized veins 25%
Pulmonary circuit 9%
Pulmonary arteries 3%
Pulmonary capillaries 2%
Pulmonary veins 4%
Heart 7%
Aorta 2%
Elastic arteries 4%
Muscular arteries 5%
Arterioles 2%
Systemic capillaries 7%
Systemic arterial system 13%

Fig 22.7



(a) The normal arterial wall consists of smooth muscle and connective tissue with an endothelial cell lining.

(b) In early stages, excess LDL-cholesterol accumulates between the endothelium and connective tissue. There, it is oxidized and phagocytosed. The macrophages produce paracrines that attract smooth muscle cells. At this stage, the lesion is called a fatty streak.

(c) As cholesterol accumulates, fibrous sca tissue forms around it. Migrating smooth muscle cells divide, thickening the arterial wall and narrowing the lumen of the artery. This stage is known as a fibrous plaque.

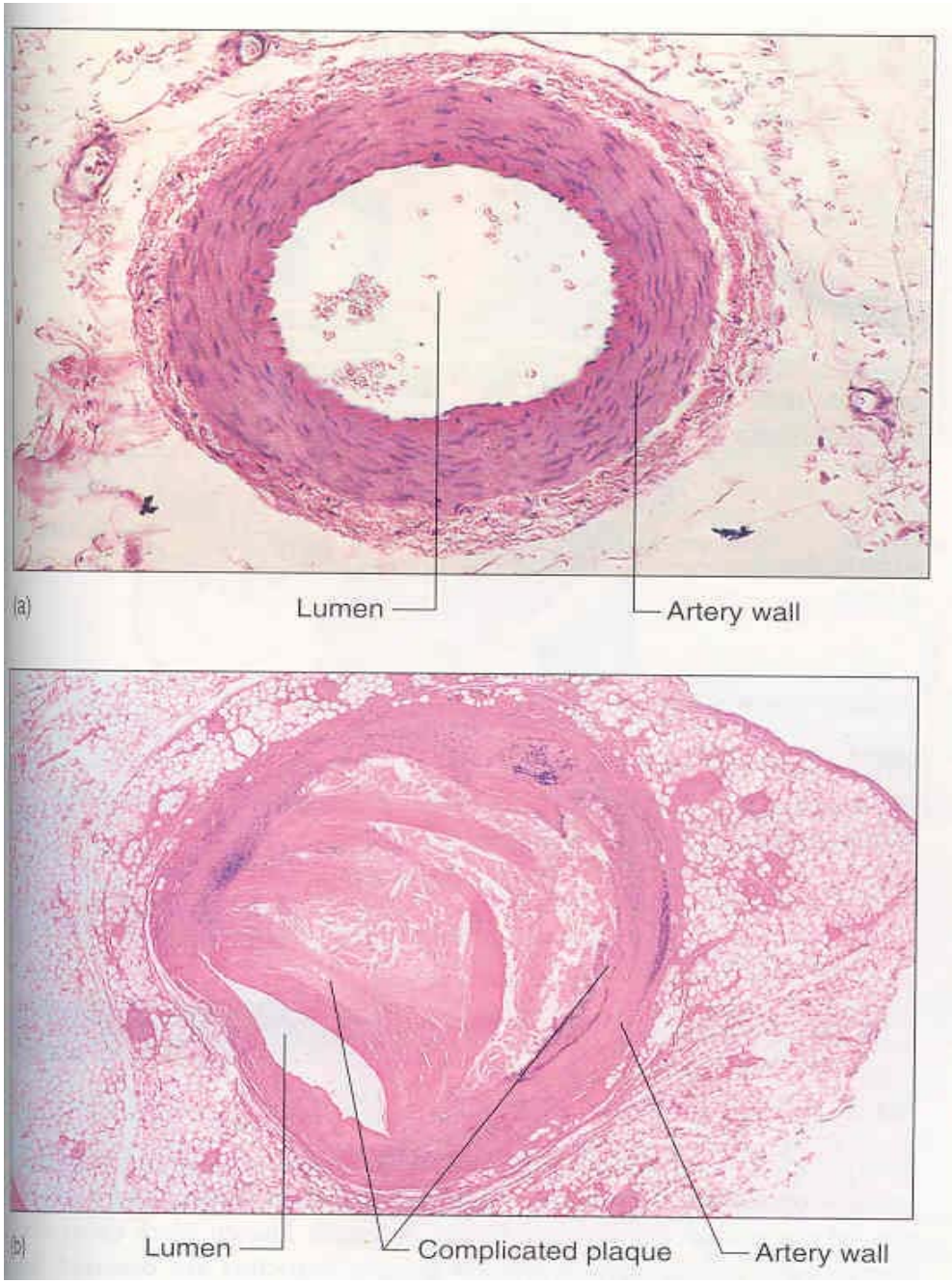
(d) In the advanced stages of atherosclerosis, calcified scar tissue will form. If the endothelium is damaged and collagen is exposed, platelets stick to the damaged area and a blood clot (thrombus) forms. If blood flow in the coronary blood vessel is stopped, a heart attack is the result.

Arteriosclerosis

= hardening of vessel wall.

Atherosclerosis

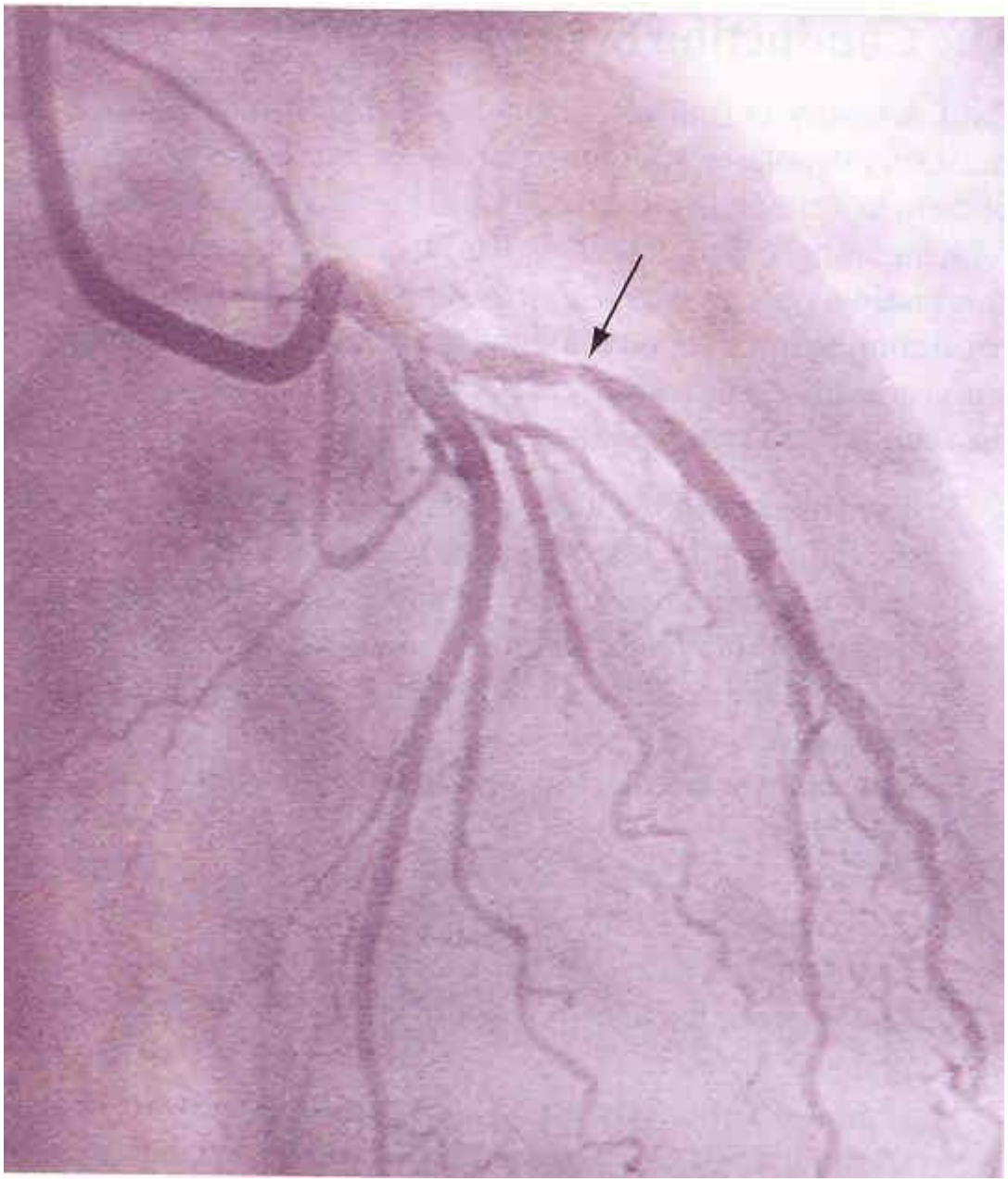
= deposits of lipids in blood vessel wall, forming a plaque. Results in a hardening and narrowing of vessel.



Cross section of a normal, healthy coronary artery.

Cross section of a coronary artery with advanced atherosclerosis.

Coronary Angiogram:



Showing 60% obstruction (arrow) of the anterior interventricular artery.

Aortic Aneurysm

Aneurysm:
a weak point in the heart or an artery wall; results in bulging due to pressure in vessel.

Poses threat of hemorrhage.

Superior

Celiac

Superior Mesenteric

Renal

Gonadal

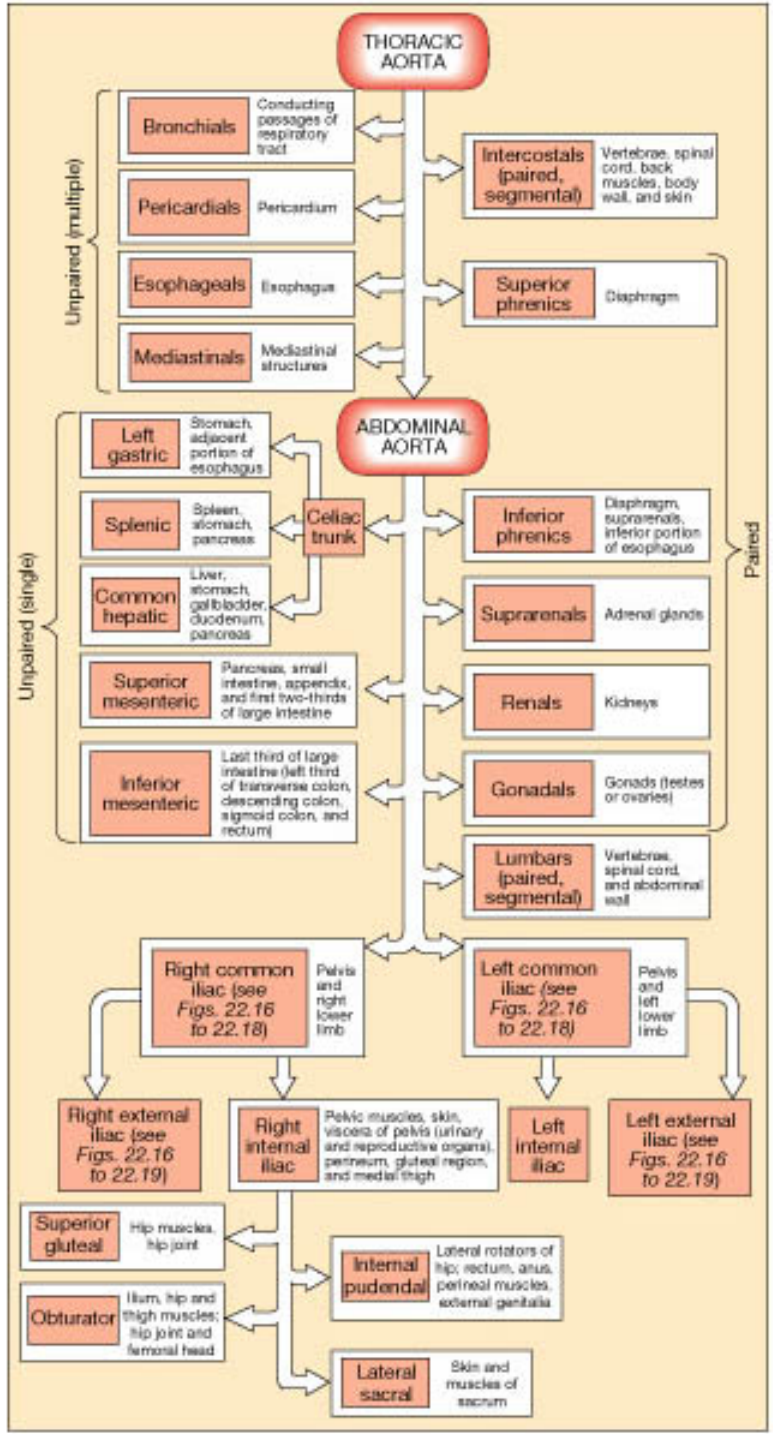
Inferior Mesenteric

Common Iliac

Inferior

gonadal artery=

ovarian in females testicular in males



Superior

Can

Small Mice

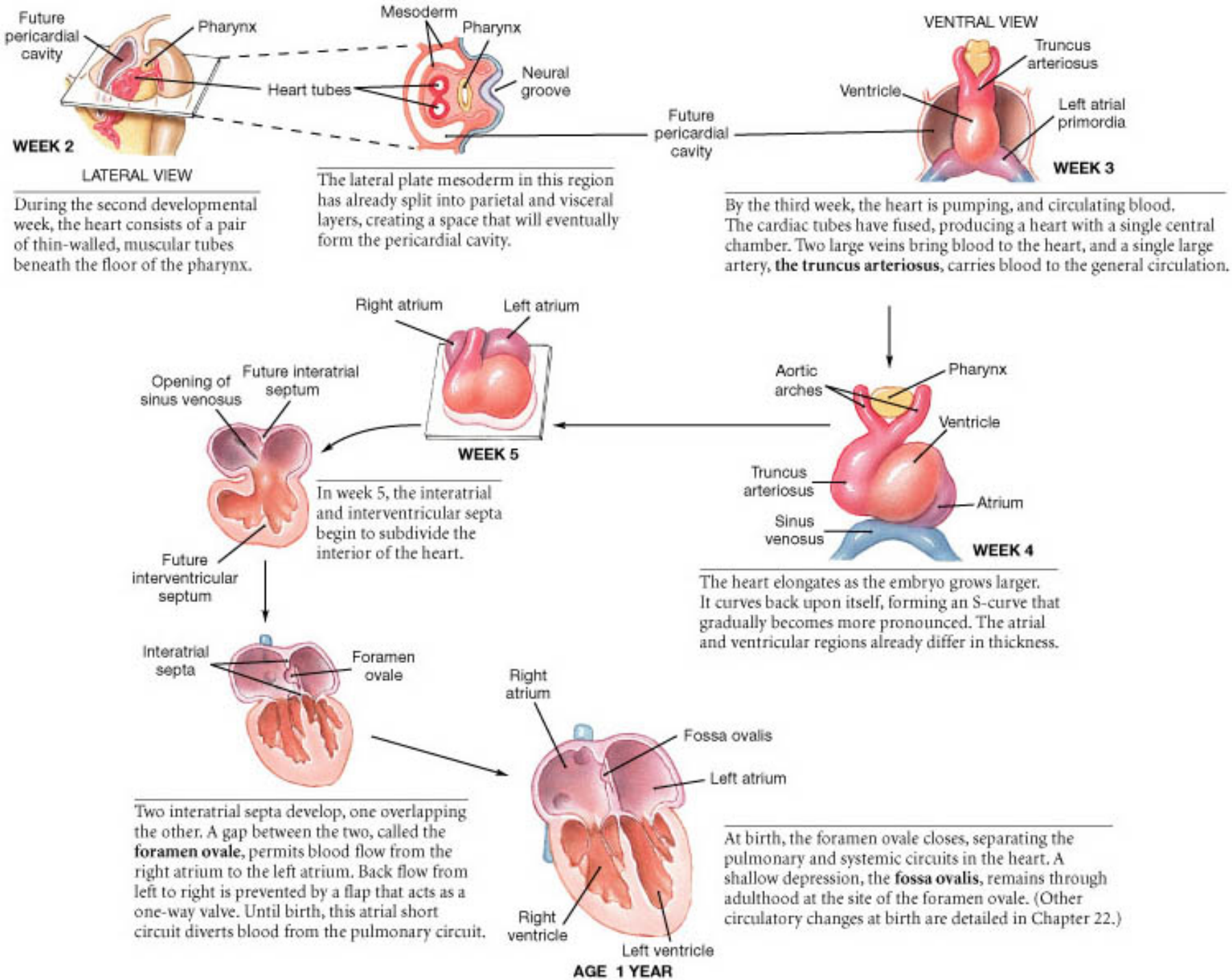
Really

Get

Into My

Cousin’s Intestines

Inferior



During the second developmental week, the heart consists of a pair of thin-walled, muscular tubes beneath the floor of the pharynx.

The lateral plate mesoderm in this region has already split into parietal and visceral layers, creating a space that will eventually form the pericardial cavity.

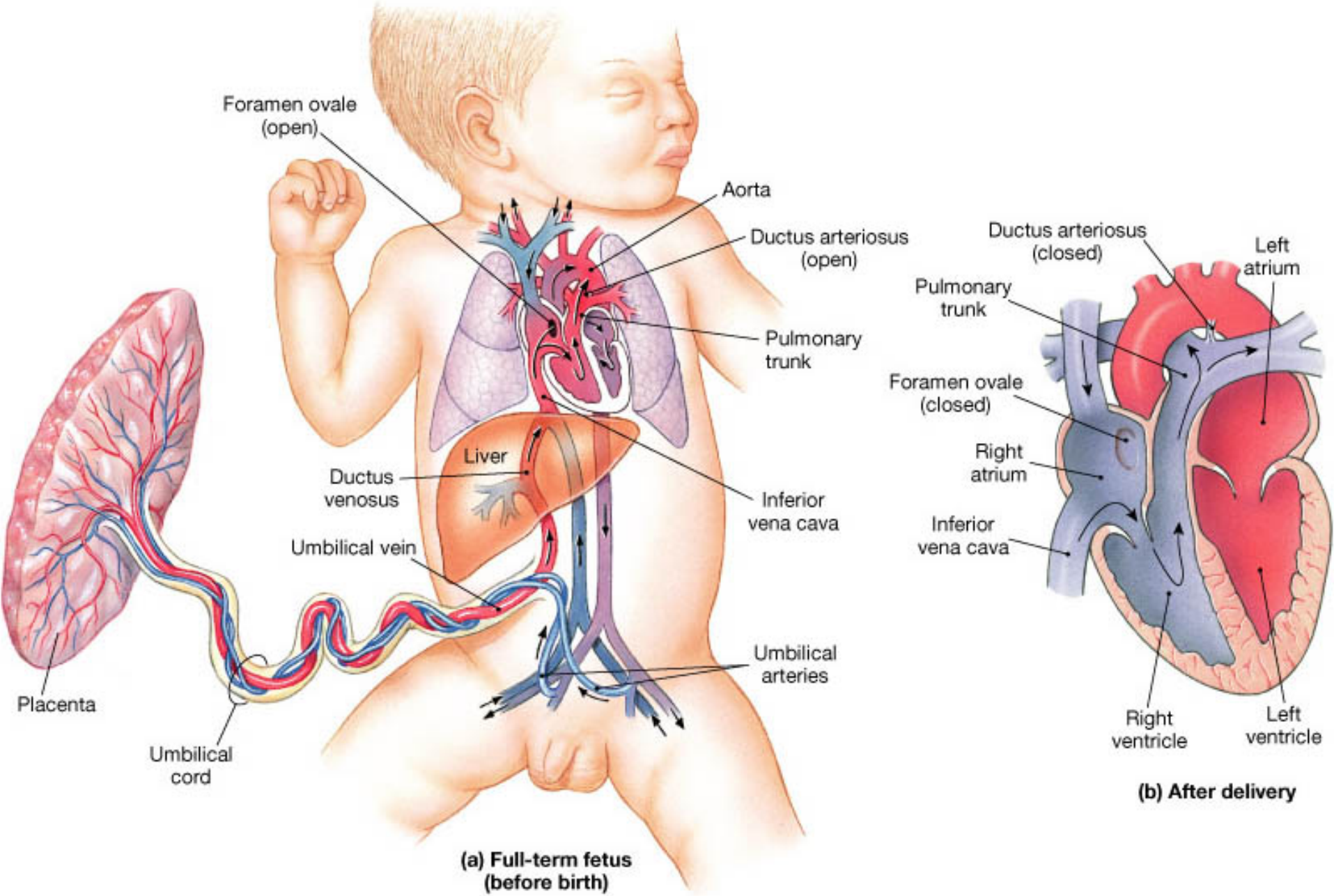
By the third week, the heart is pumping, and circulating blood. The cardiac tubes have fused, producing a heart with a single central chamber. Two large veins bring blood to the heart, and a single large artery, **the truncus arteriosus**, carries blood to the general circulation.

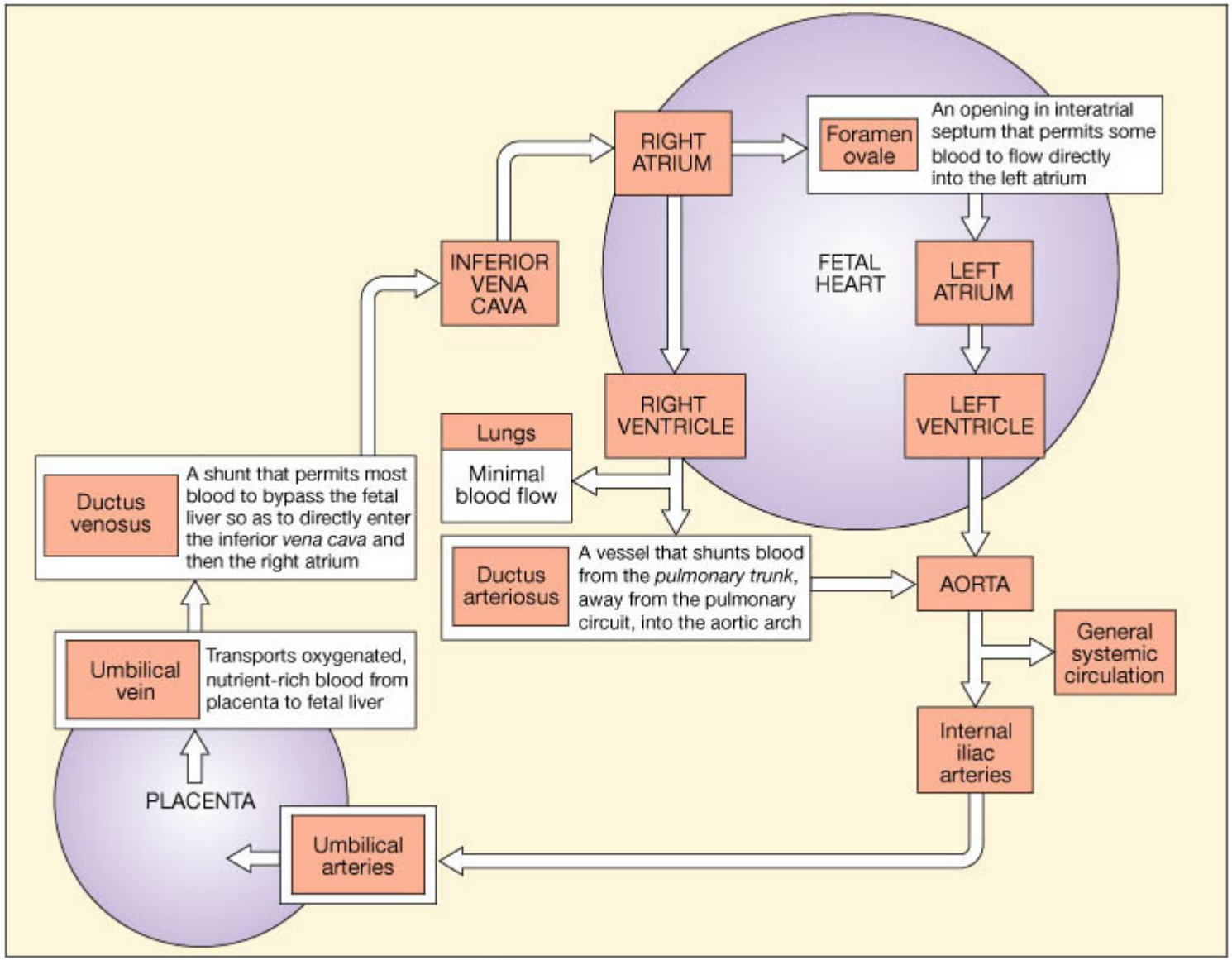
In week 5, the interatrial and interventricular septa begin to subdivide the interior of the heart.

The heart elongates as the embryo grows larger. It curves back upon itself, forming an S-curve that gradually becomes more pronounced. The atrial and ventricular regions already differ in thickness.

Two interatrial septa develop, one overlapping the other. A gap between the two, called the **foramen ovale**, permits blood flow from the right atrium to the left atrium. Back flow from left to right is prevented by a flap that acts as a one-way valve. Until birth, this atrial short circuit diverts blood from the pulmonary circuit.

At birth, the foramen ovale closes, separating the pulmonary and systemic circuits in the heart. A shallow depression, the **fossa ovalis**, remains through adulthood at the site of the foramen ovale. (Other circulatory changes at birth are detailed in Chapter 22.)


Foramen ovale
(open)
Aorta
Ductus arteriosus
(open)
Pulmonary
trunk
Liver
Ductus
venosus
Inferior
vena cava
Umbilical vein
Umbilical
arteries
Placenta
Umbilical
cord
(a) Full-term fetus
(before birth)
Ductus arteriosus
(closed)
Left
atrium
Pulmonary
trunk
Foramen ovale
(closed)
Right
atrium
Inferior
vena cava
Right
ventricle
Left
ventricle
(b) After delivery



(c) Fetal circulatory pattern

Interactive cd & Histology cd

- Cat dissection
- Opening the ventral cavity
-
- Lay cat on its dorsal surface
- Make incisions, cutting through the muscle, as seen in the figure below
- Fold back the flaps of tissue to expose the ventral cavity

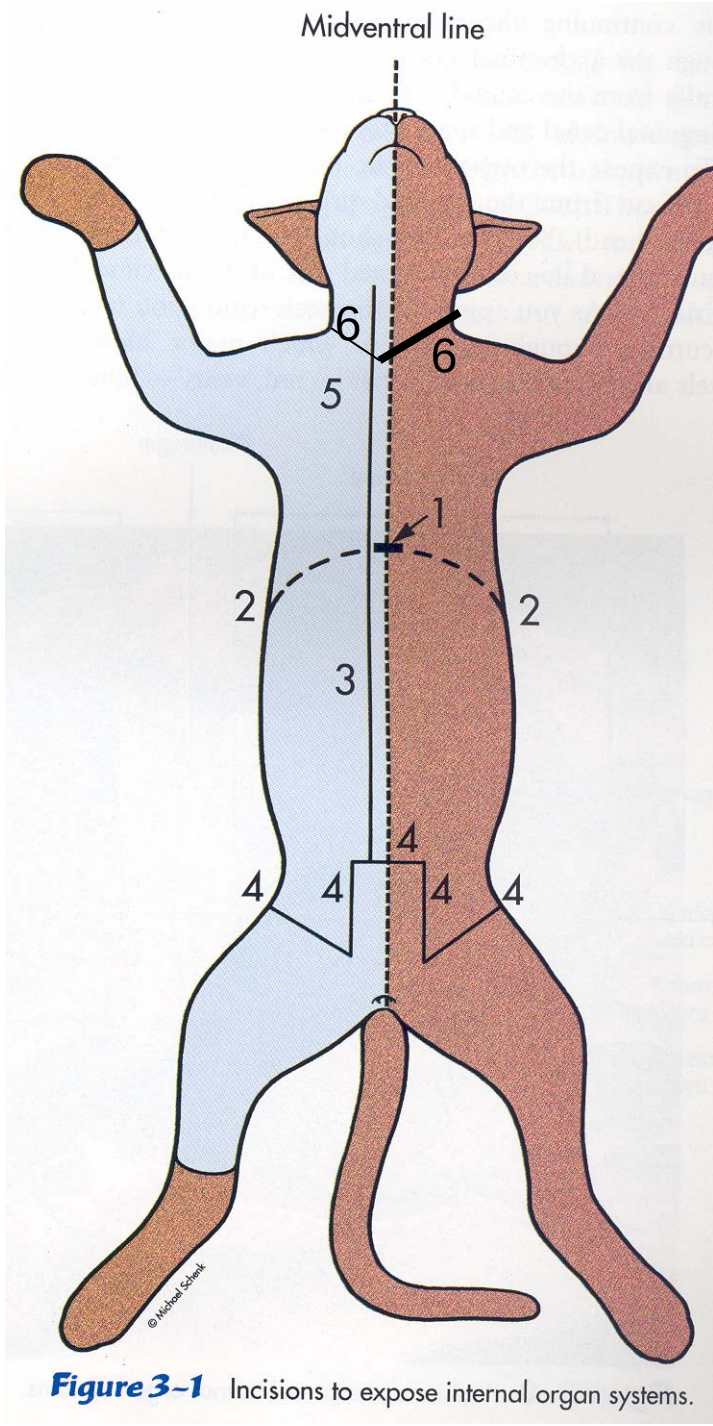
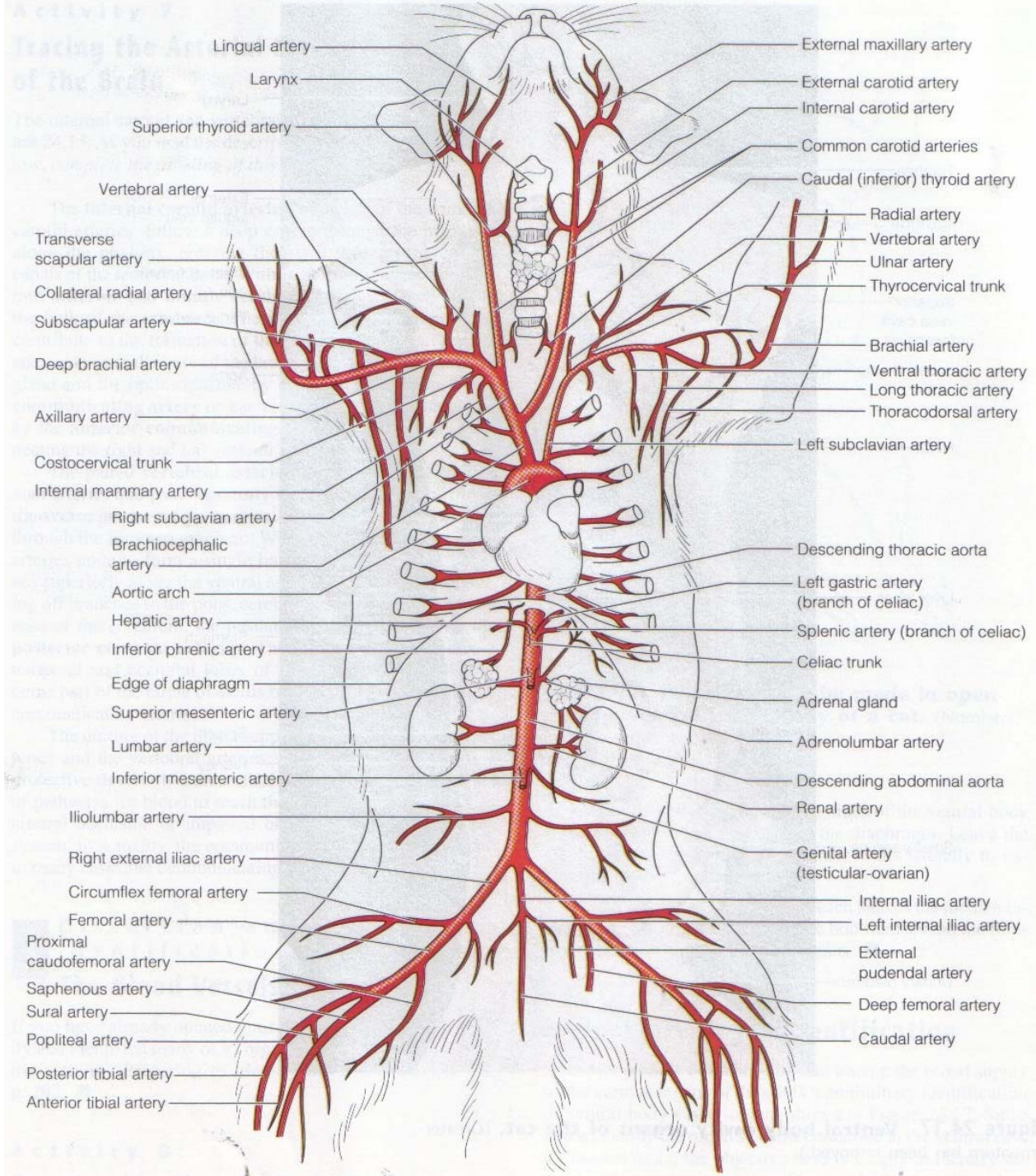
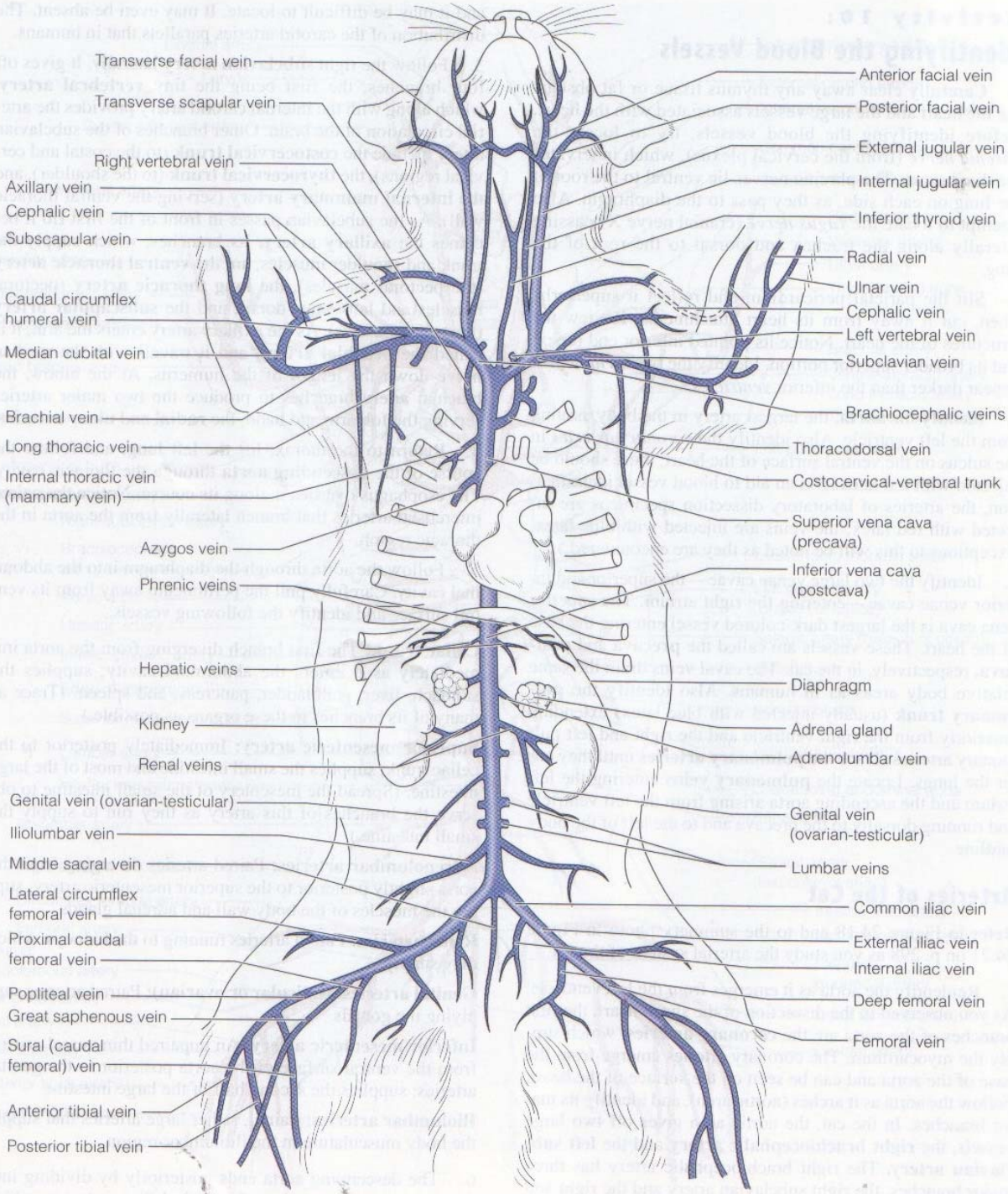
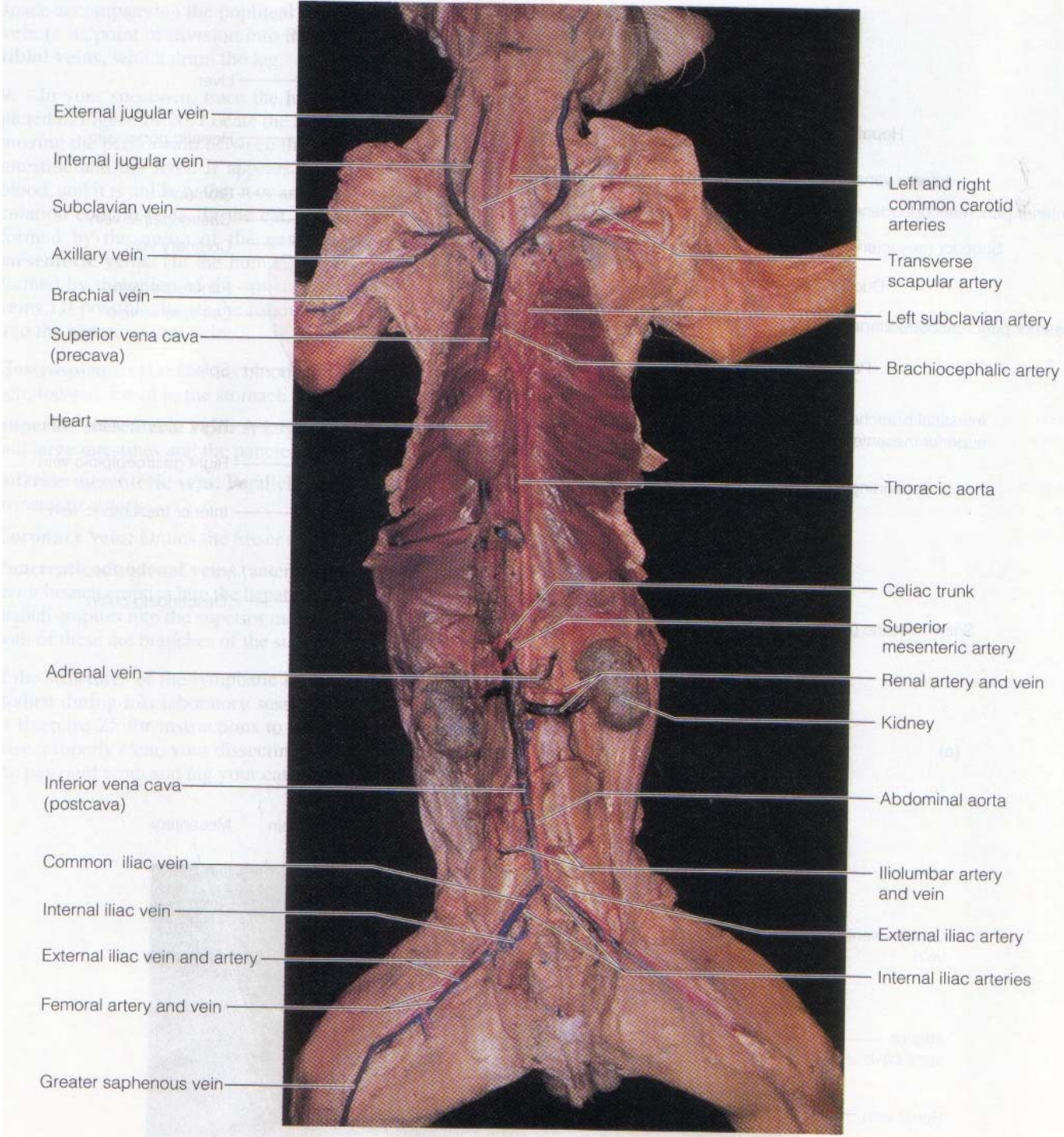


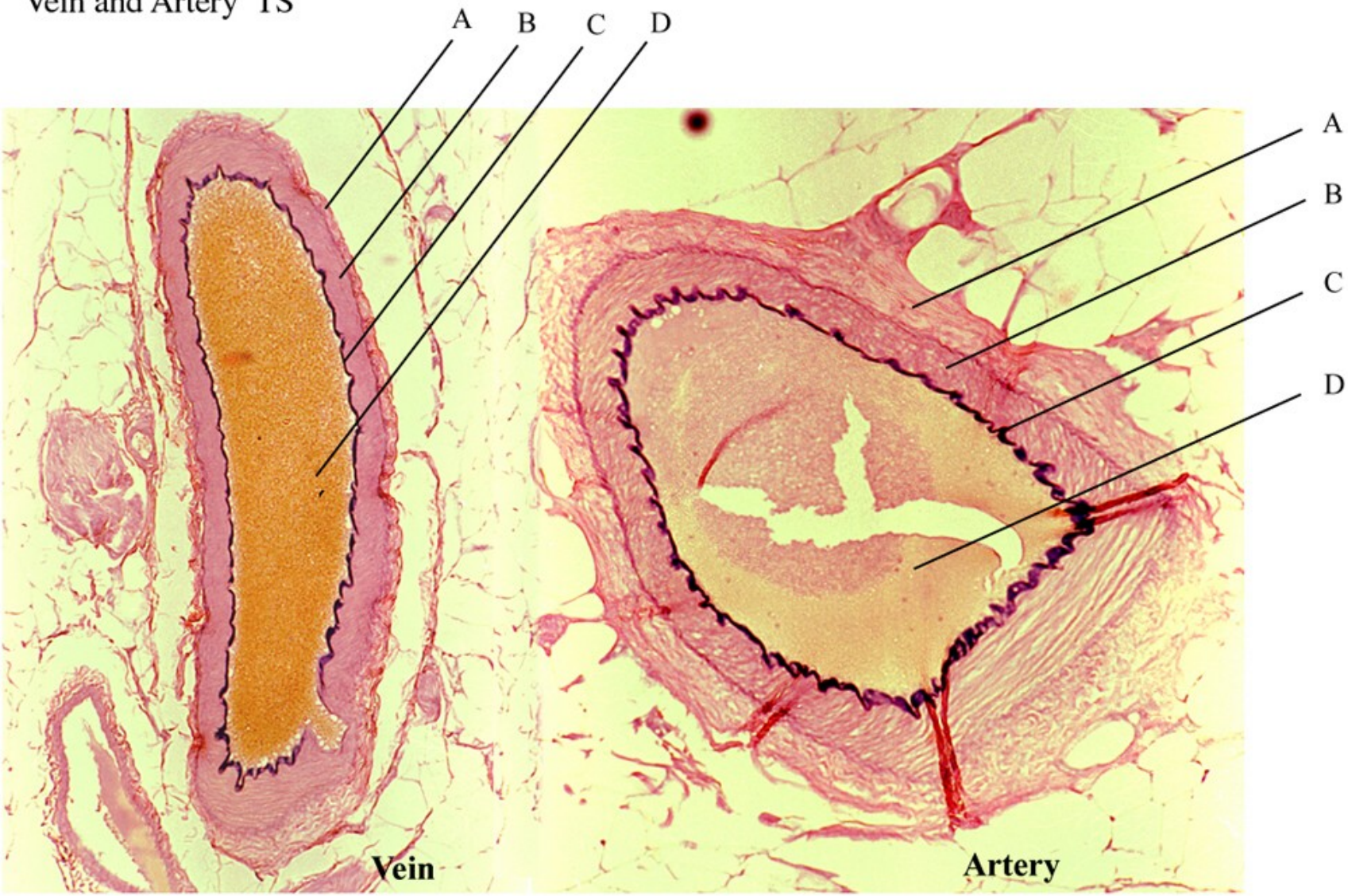
Figure 3–1 Incisions to expose internal organ systems.


Lingual artery
Larynx
Superior thyroid artery
Vertebral artery
Transverse scapular artery
Collateral radial artery
Subscapular artery
Deep brachial artery
Axillary artery
Costocervical trunk
Internal mammary artery
Right subclavian artery
Brachiocephalic artery
Aortic arch
Hepatic artery
Inferior phrenic artery
Edge of diaphragm
Superior mesenteric artery
Lumbar artery
Inferior mesenteric artery
Iliolumbar artery
Right external iliac artery
Circumflex femoral artery
Femoral artery
Proximal caudofemoral artery
Saphenous artery
Sural artery
Popliteal artery
Posterior tibial artery
Anterior tibial artery
External maxillary artery
External carotid artery
Internal carotid artery
Common carotid arteries
Caudal (inferior) thyroid artery
Radial artery
Vertebral artery
Ulnar artery
Thyrocervical trunk
Brachial artery
Ventral thoracic artery
Long thoracic artery
Thoracodorsal artery
Left subclavian artery
Descending thoracic aorta
Left gastric artery (branch of celiac)
Splenic artery (branch of celiac)
Celiac trunk
Adrenal gland
Adrenolumbar artery
Descending abdominal aorta
Renal artery
Genital artery (testicular-ovarian)
Internal iliac artery
Left internal iliac artery
External pudendal artery
Deep femoral artery
Caudal artery

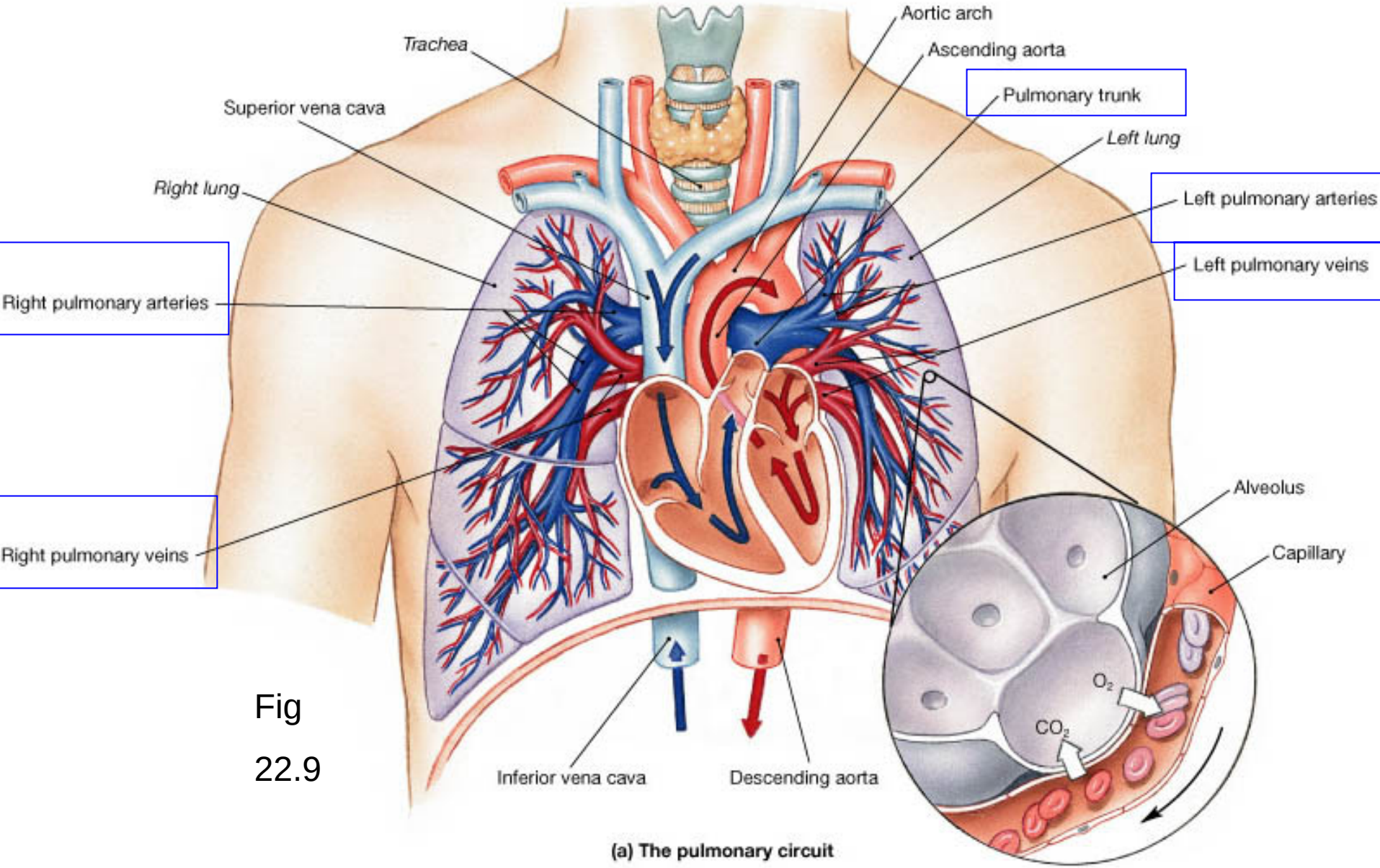

Transverse facial vein
Transverse scapular vein
Right vertebral vein
Axillary vein
Cephalic vein
Subscapular vein
Caudal circumflex humeral vein
Median cubital vein
Brachial vein
Long thoracic vein
Internal thoracic vein (mammary vein)
Azygos vein
Phrenic veins
Hepatic veins
Kidney
Renal veins
Genital vein (ovarian-testicular)
Iliolumbar vein
Middle sacral vein
Lateral circumflex femoral vein
Proximal caudal femoral vein
Popliteal vein
Great saphenous vein
Sural (caudal femoral) vein
Anterior tibial vein
Posterior tibial vein
Anterior facial vein
Posterior facial vein
External jugular vein
Internal jugular vein
Inferior thyroid vein
Radial vein
Ulnar vein
Cephalic vein
Left vertebral vein
Subclavian vein
Brachiocephalic veins
Thoracodorsal vein
Costocervical-vertebral trunk
Superior vena cava (precava)
Inferior vena cava (postcava)
Diaphragm
Adrenal gland
Adrenolumbar vein
Genital vein (ovarian-testicular)
Lumbar veins
Common iliac vein
External iliac vein
Internal iliac vein
Deep femoral vein
Femoral vein


External jugular vein
Internal jugular vein
Subclavian vein
Axillary vein
Brachial vein
Superior vena cava (precava)
Heart
Adrenal vein
Inferior vena cava (postcava)
Common iliac vein
Internal iliac vein
External iliac vein and artery
Femoral artery and vein
Greater saphenous vein
Left and right common carotid arteries
Transverse scapular artery
Left subclavian artery
Brachiocephalic artery
Thoracic aorta
Celiac trunk
Superior mesenteric artery
Renal artery and vein
Kidney
Abdominal aorta
Iliolumbar artery and vein
External iliac artery
Internal iliac arteries

Vein and Artery TS

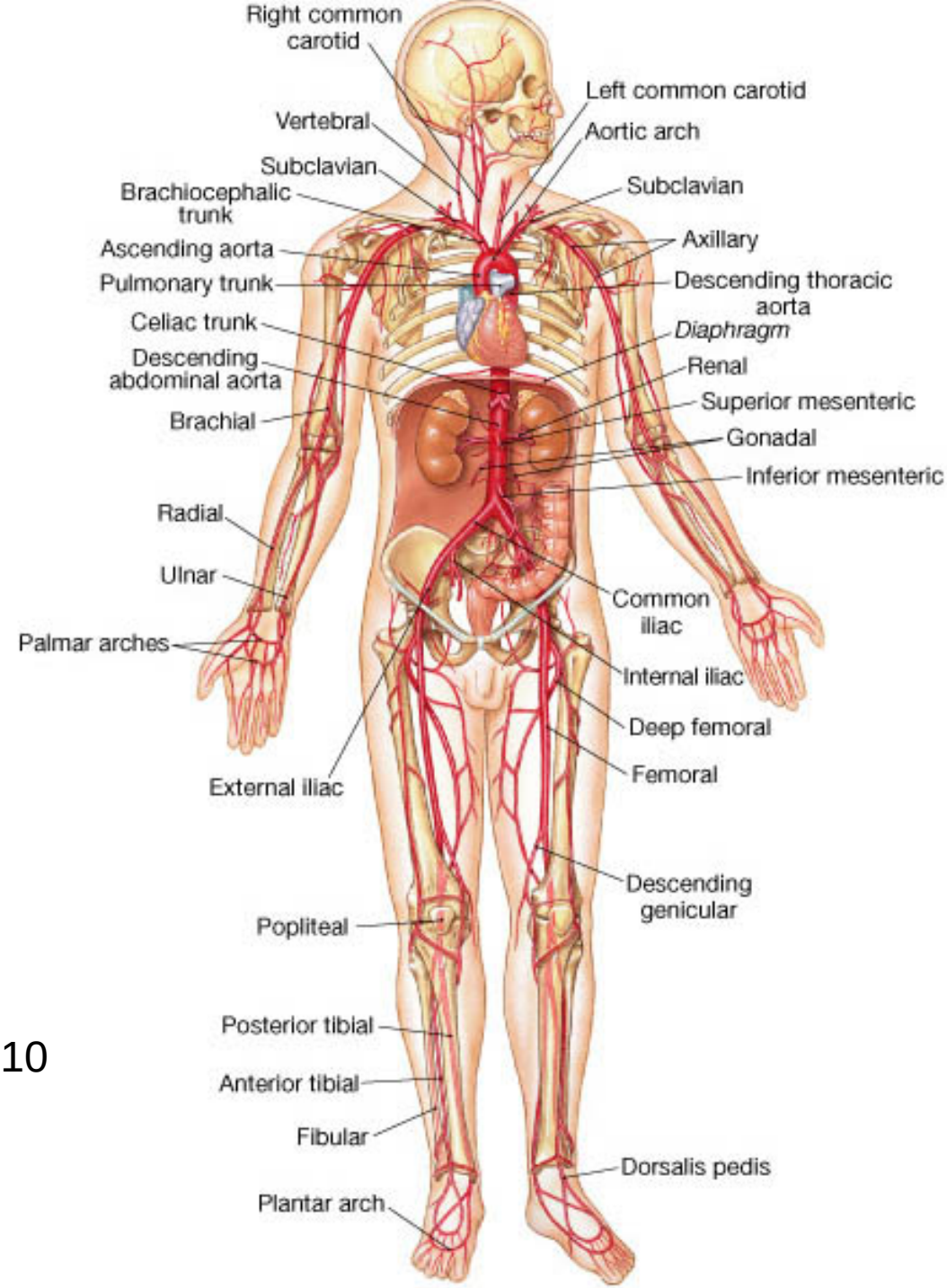


A - layer of elastic fibres (tunica adventitia)
B - layer of smooth muscles and elastic fibres (tunica media)
C - endothelium and elastin (tunica intima)
D - blood


Trachea
Aortic arch
Ascending aorta
Pulmonary trunk
Superior vena cava
Left lung
Right lung
Left pulmonary arteries
Left pulmonary veins
Right pulmonary arteries
Right pulmonary veins
Alveolus
Capillary
O_2
CO_2
Inferior vena cava
Descending aorta
(a) The pulmonary circuit

Fig

22.9


Right common carotid
Left common carotid
Vertebral
Aortic arch
Subclavian
Brachiocephalic trunk
Subclavian
Ascending aorta
Axillary
Pulmonary trunk
Descending thoracic aorta
Celiac trunk
Diaphragm
Descending abdominal aorta
Renal
Superior mesenteric
Brachial
Gonadal
Inferior mesenteric
Radial
Ulnar
Common iliac
Palmar arches
Internal iliac
Deep femoral
External iliac
Femoral
Descending genicular
Popliteal
Posterior tibial
Anterior tibial
Fibular
Dorsalis pedis
Plantar arch

Fig

22.10

Fig 21.6

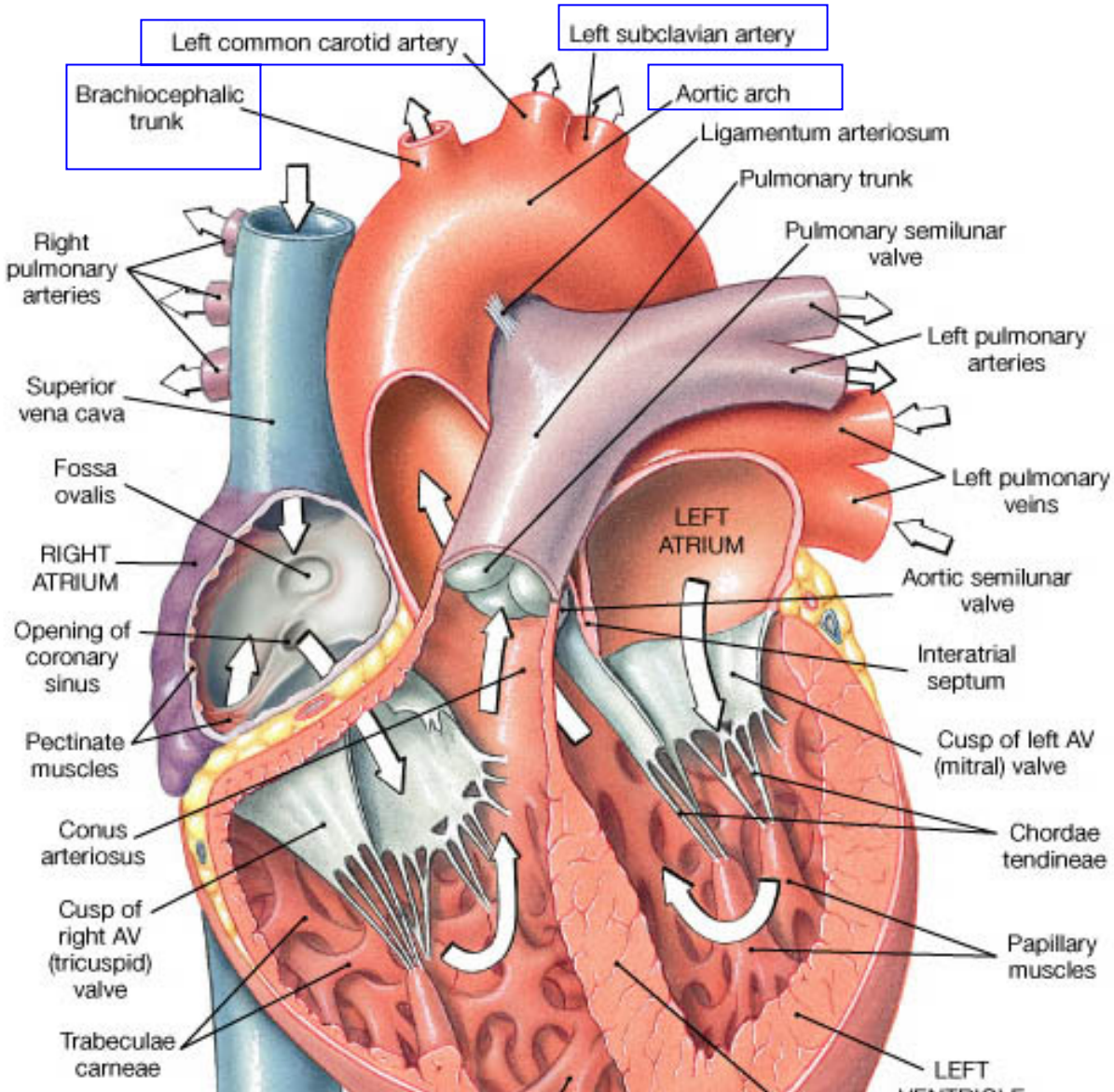
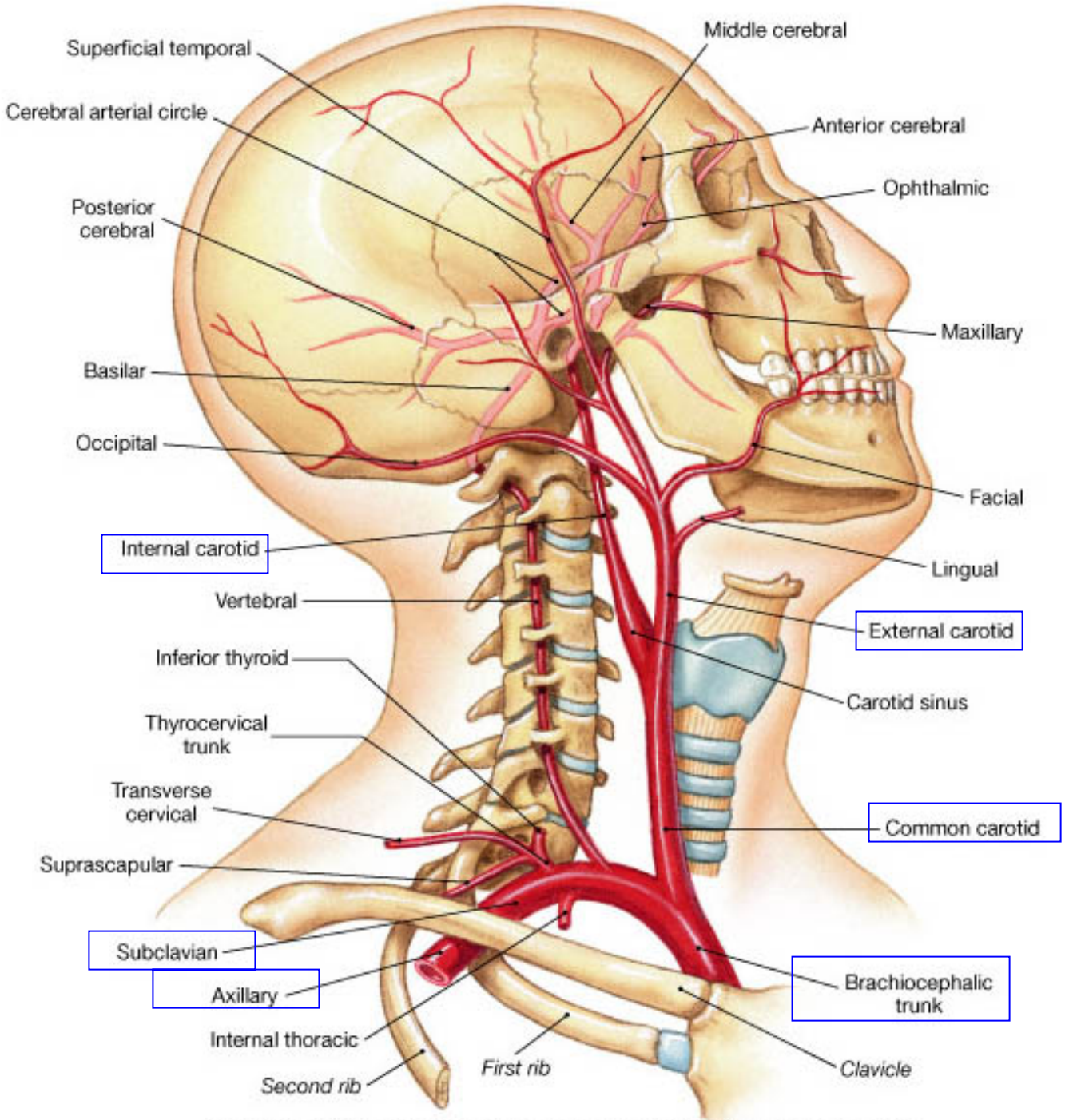
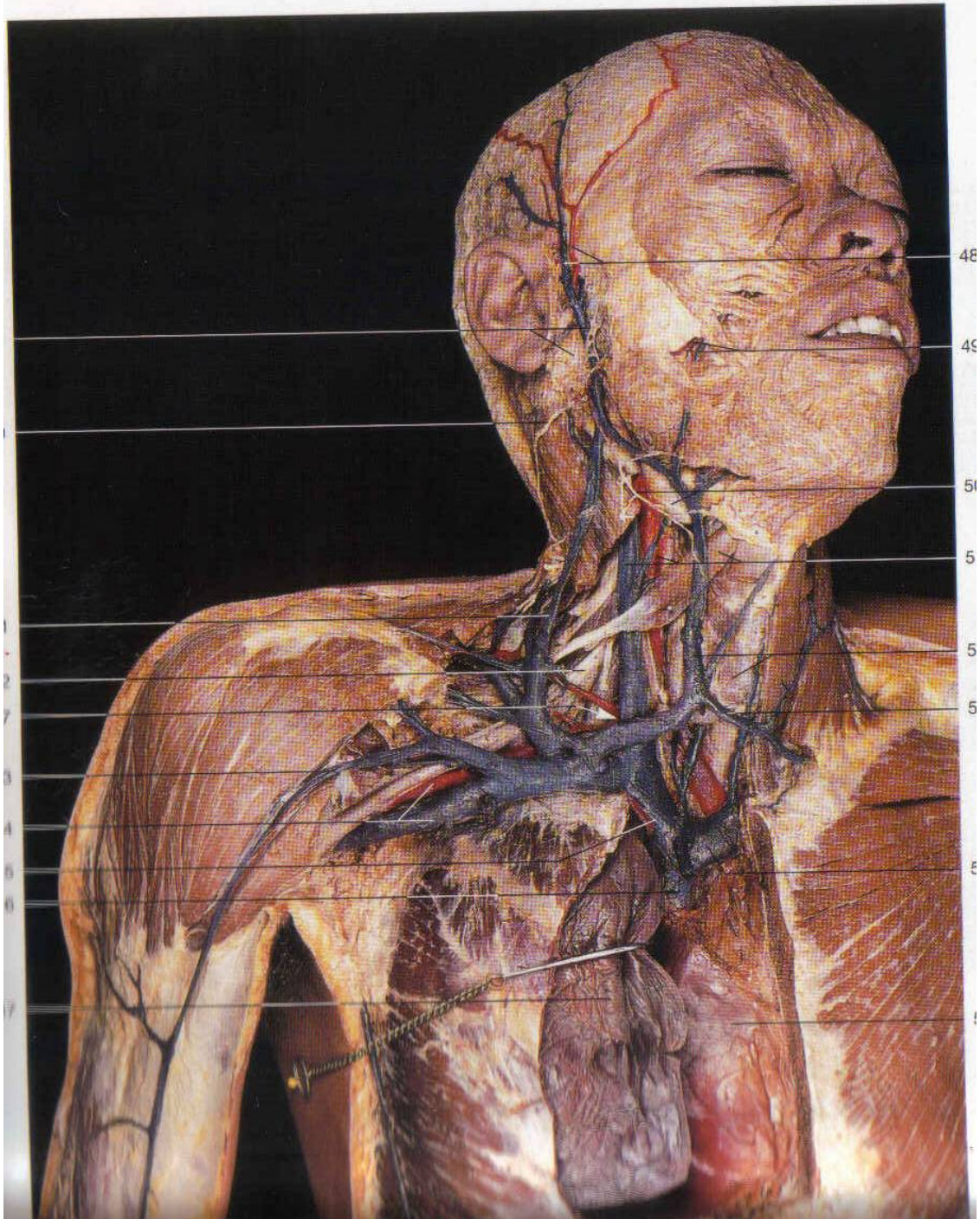

Left common carotid artery
Left subclavian artery
Brachiocephalic trunk
Aortic arch
Ligamentum arteriosum
Pulmonary trunk
Pulmonary semilunar valve
Right pulmonary arteries
Left pulmonary arteries
Superior vena cava
Fossa ovalis
Left pulmonary veins
LEFT ATRIUM
RIGHT ATRIUM
Aortic semilunar valve
Opening of coronary sinus
Interatrial septum
Pectinate muscles
Cusp of left AV (mitral) valve
Conus arteriosus
Chordae tendineae
Cusp of right AV (tricuspid) valve
Papillary muscles
Trabeculae carneae
LEFT

Fig 22.13



(a) Arteries of neck and head, an oblique lateral view from the right side



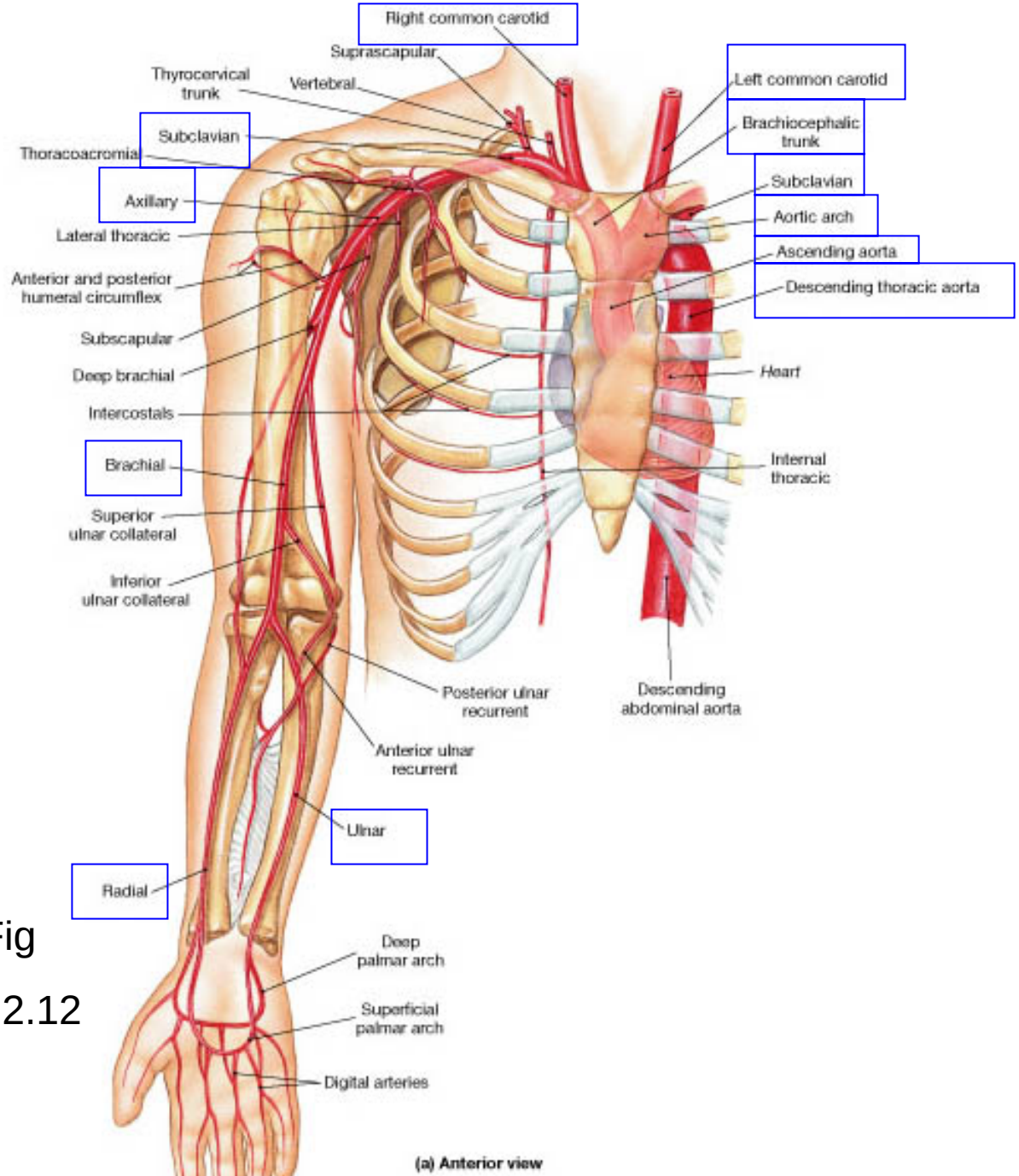
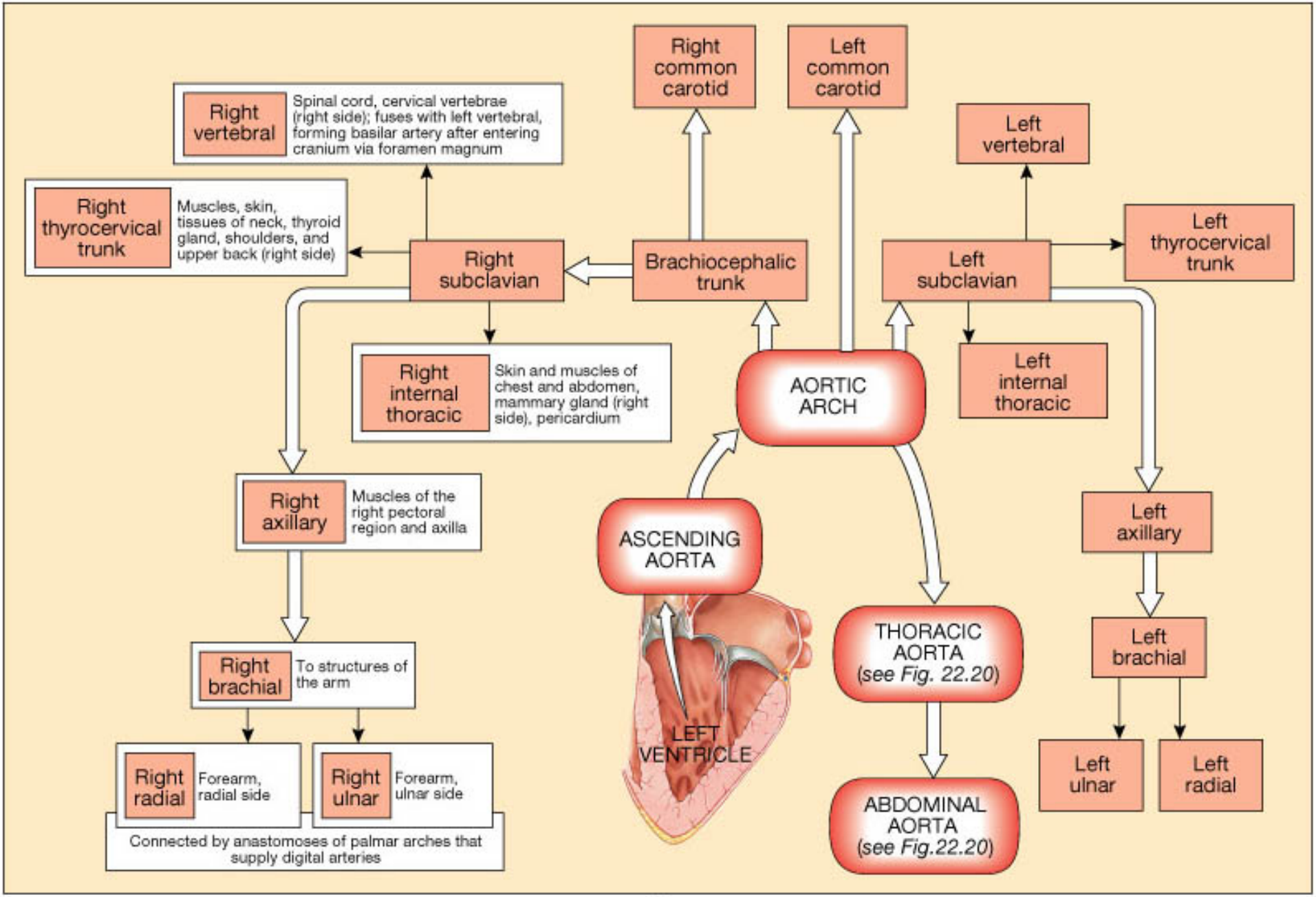

Right common carotid
Suprascapular
Thyrocervical trunk
Vertebral
Subclavian
Thoracoacromial
Axillary
Lateral thoracic
Anterior and posterior humeral circumflex
Subscapular
Deep brachial
Intercostals
Brachial
Superior ulnar collateral
Inferior ulnar collateral
Posterior ulnar recurrent
Anterior ulnar recurrent
Ulnar
Radial
Deep palmar arch
Superficial palmar arch
Digital arteries
Left common carotid
Brachiocephalic trunk
Subclavian
Aortic arch
Ascending aorta
Descending thoracic aorta
Heart
Internal thoracic
Descending abdominal aorta
(a) Anterior view

Fig 22.12


Right common carotid
Left common carotid
Right vertebral
Spinal cord, cervical vertebrae (right side); fuses with left vertebral, forming basilar artery after entering cranium via foramen magnum
Left vertebral
Right thyrocervical trunk
Muscles, skin, tissues of neck, thyroid gland, shoulders, and upper back (right side)
Left thyrocervical trunk
Right subclavian
Brachiocephalic trunk
Left subclavian
Right internal thoracic
Skin and muscles of chest and abdomen, mammary gland (right side), pericardium
AORTIC ARCH
Left internal thoracic
Right axillary
Muscles of the right pectoral region and axilla
ASCENDING AORTA
Left axillary
Right brachial
To structures of the arm
THORACIC AORTA (see Fig. 22.20)
Left brachial
LEFT VENTRICLE
Right radial
Forearm, radial side
Right ulnar
Forearm, ulnar side
Left ulnar
Left radial
ABDOMINAL AORTA (see Fig.22.20)
Connected by anastomoses of palmar arches that supply digital arteries

(d)

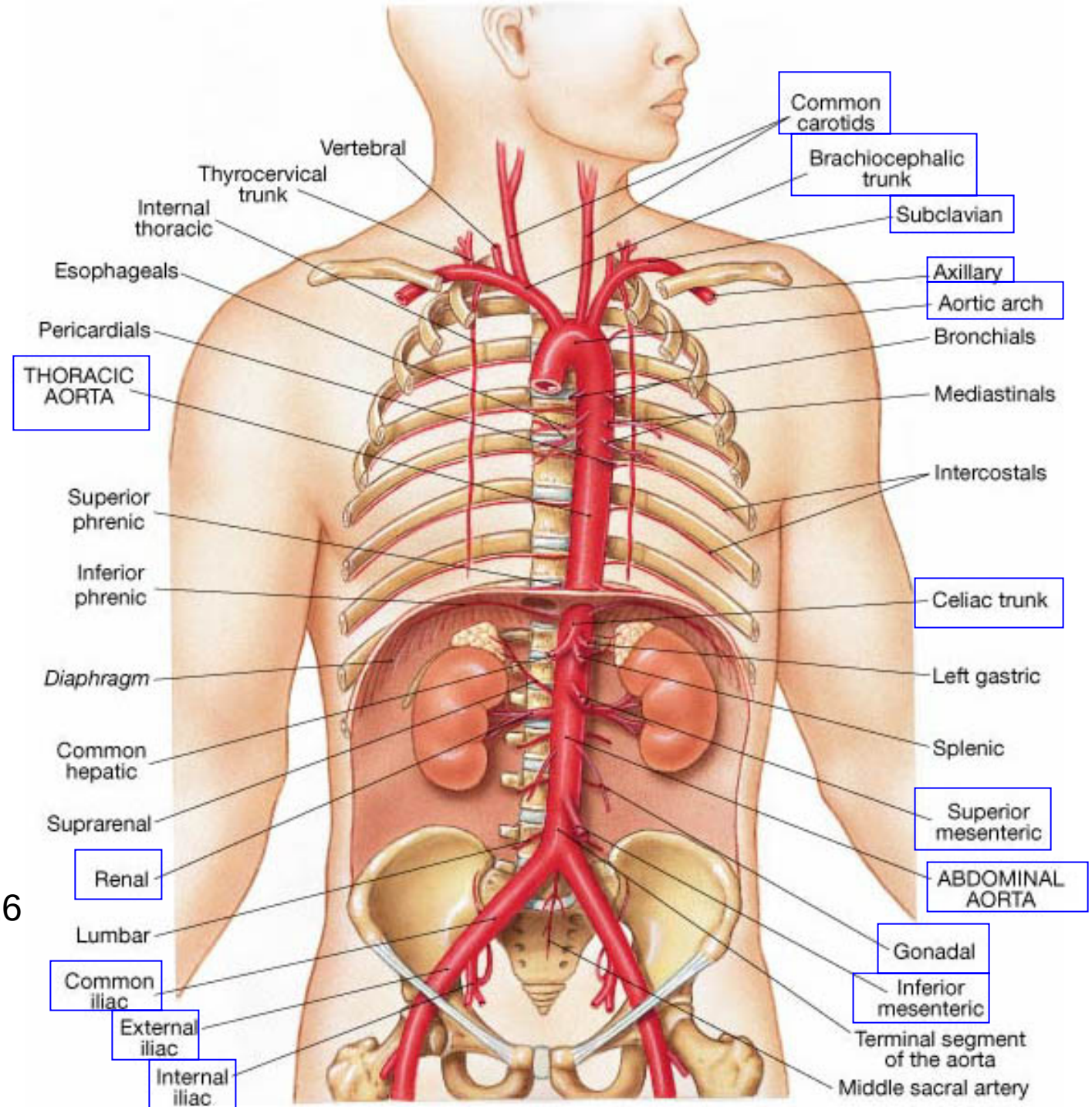
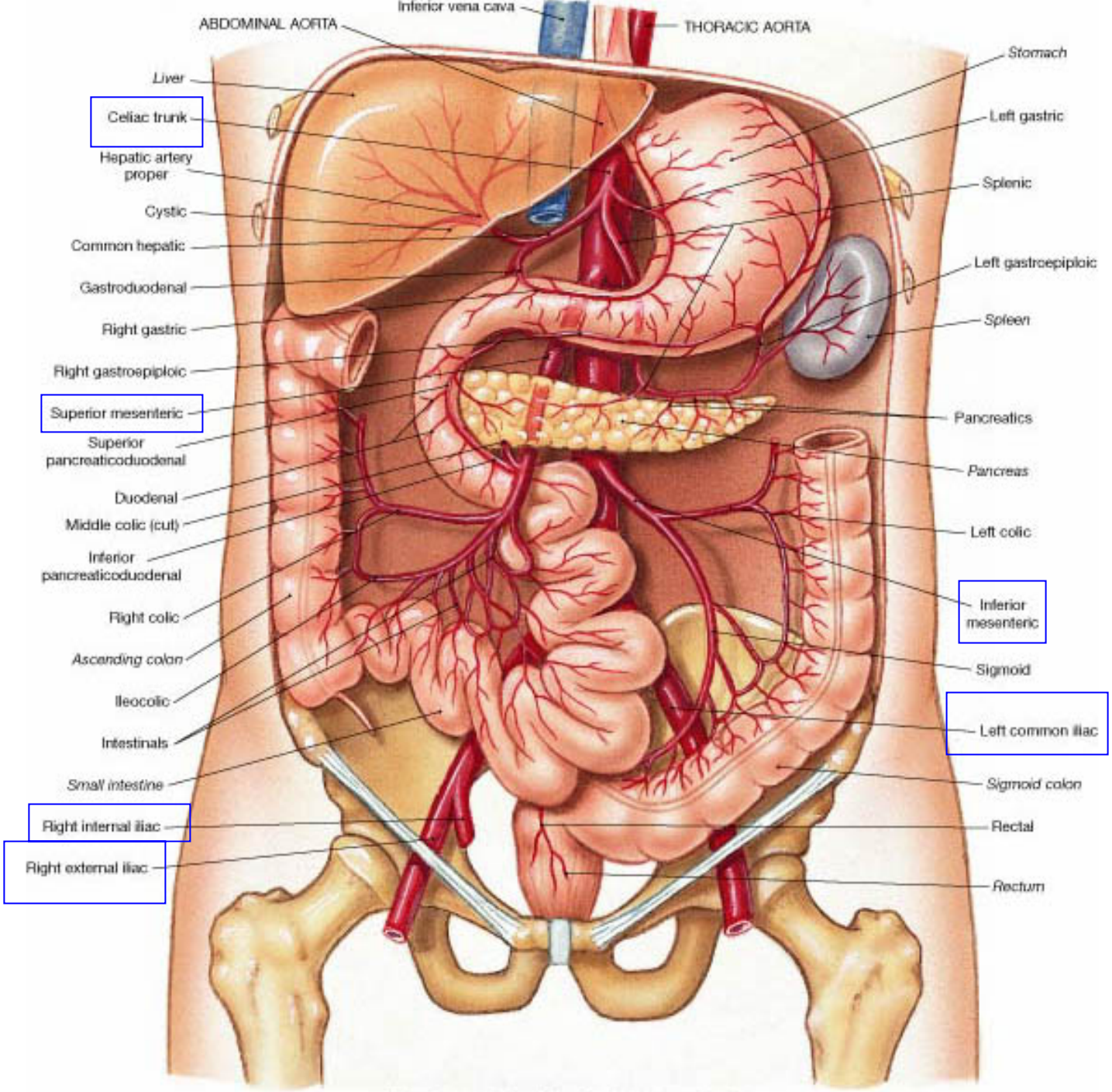
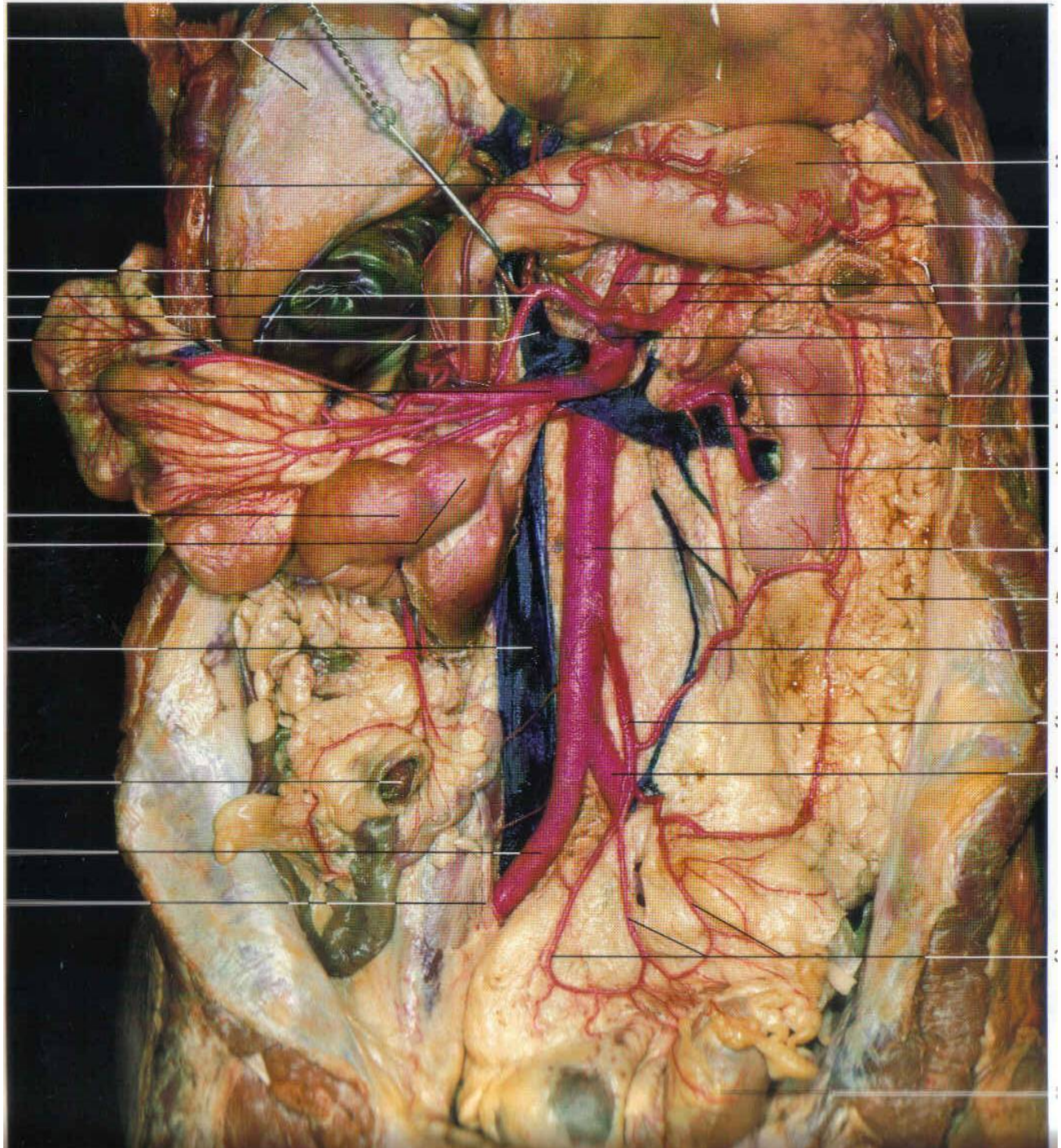

Common carotids
Vertebral
Thyrocervical trunk
Brachiocephalic trunk
Internal thoracic
Subclavian
Esophageals
Axillary
Aortic arch
Pericardials
Bronchials
THORACIC AORTA
Mediastinals
Intercostals
Superior phrenic
Inferior phrenic
Celiac trunk
Diaphragm
Left gastric
Splenic
Common hepatic
Suprarenal
Superior mesenteric
Renal
ABDOMINAL AORTA
Lumbar
Gonadal
Common iliac
Inferior mesenteric
External iliac
Terminal segment of the aorta
Internal iliac
Middle sacral artery

Fig 22.16

Fig 22.17

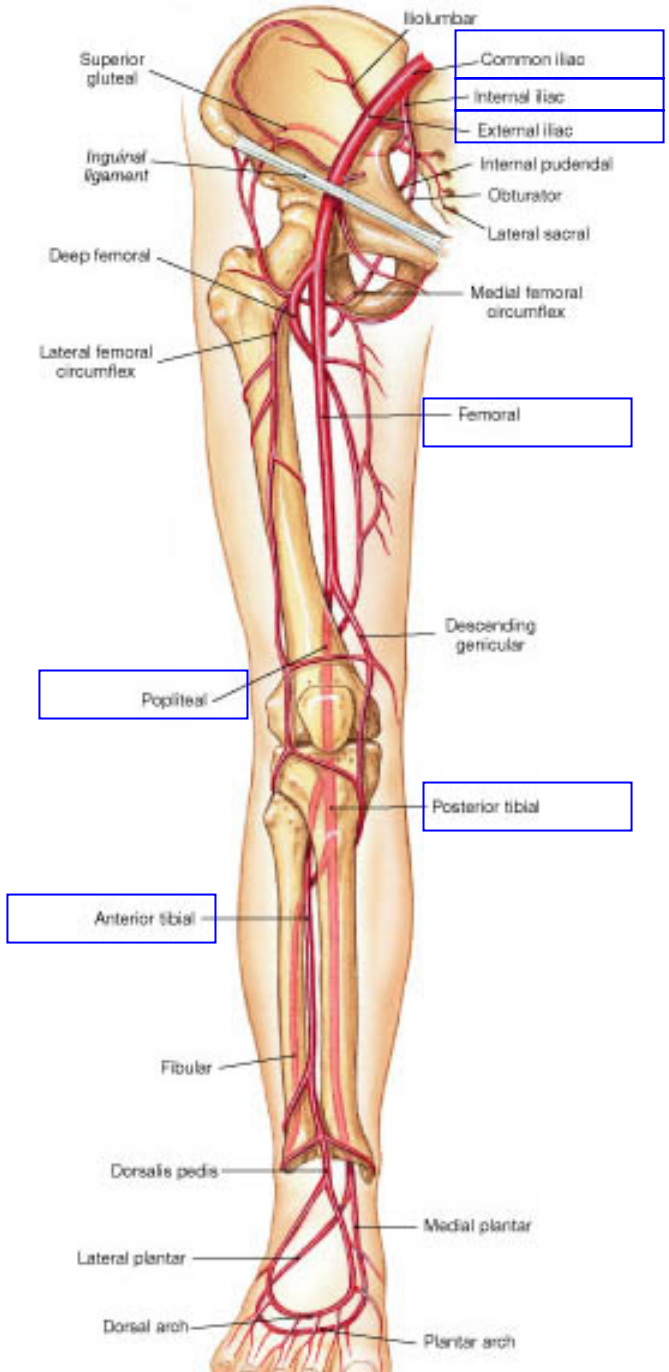


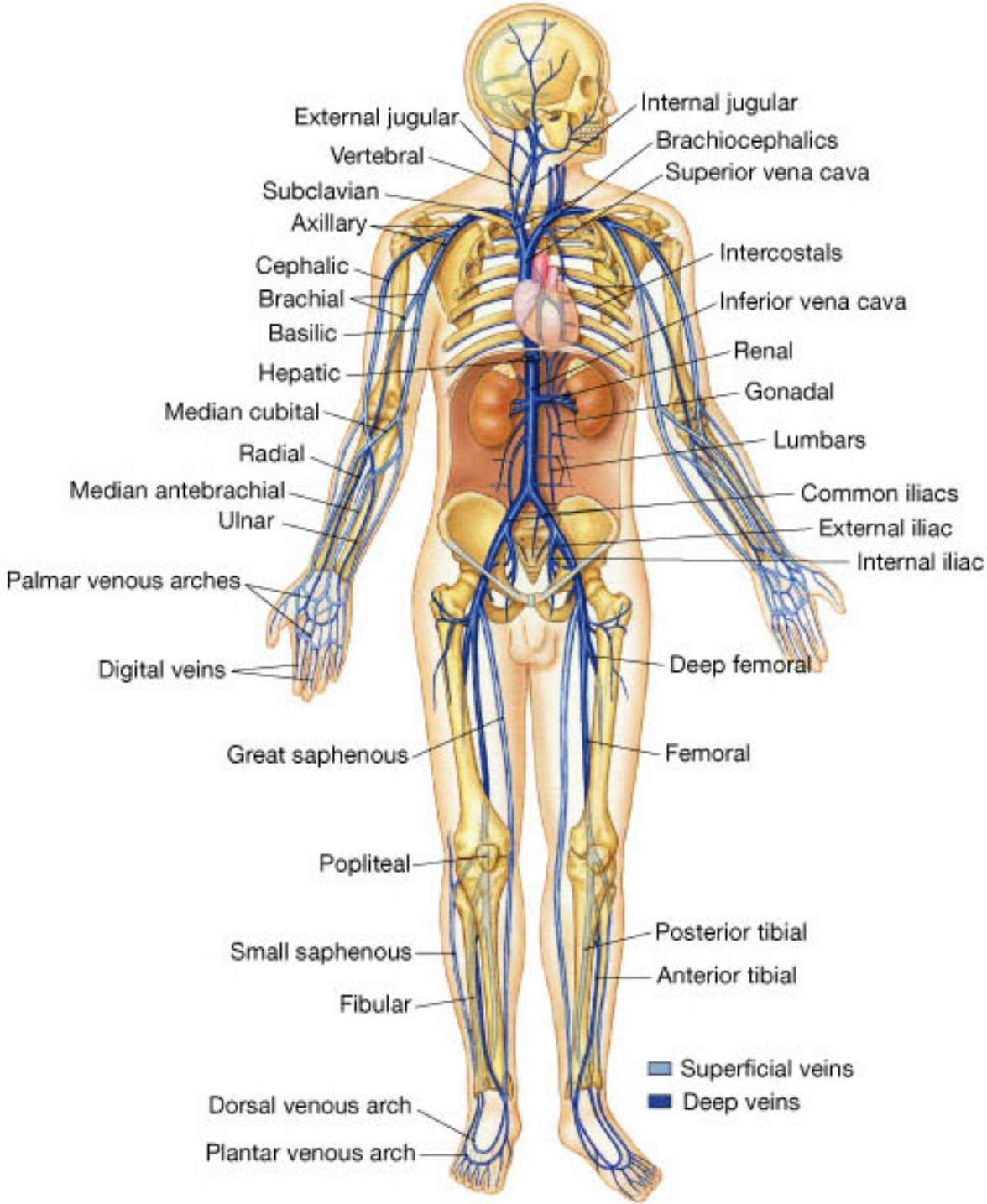
(b) Arteries supplying abdominal organs, anterior view



Fig

22.18


Iliolumbar
Superior gluteal
Common iliac
Internal iliac
External iliac
Inguinal ligament
Internal pudendal
Obturator
Lateral sacral
Deep femoral
Medial femoral circumflex
Lateral femoral circumflex
Femoral
Descending genicular
Popliteal
Posterior tibial
Anterior tibial
Fibular
Dorsalis pedis
Medial plantar
Lateral plantar
Dorsal arch
Plantar arch


External jugular
Vertebral
Subclavian
Axillary
Cephalic
Brachial
Basilic
Hepatic
Median cubital
Radial
Median antebrachial
Ulnar
Palmar venous arches
Digital veins
Internal jugular
Brachiocephalics
Superior vena cava
Intercostals
Inferior vena cava
Renal
Gonadal
Lumbars
Common iliacs
External iliac
Internal iliac
Deep femoral
Great saphenous
Femoral
Popliteal
Posterior tibial
Small saphenous
Anterior tibial
Fibular
Superficial veins
Deep veins
Dorsal venous arch
Plantar venous arch

Fig

21.21

Fig 21.6

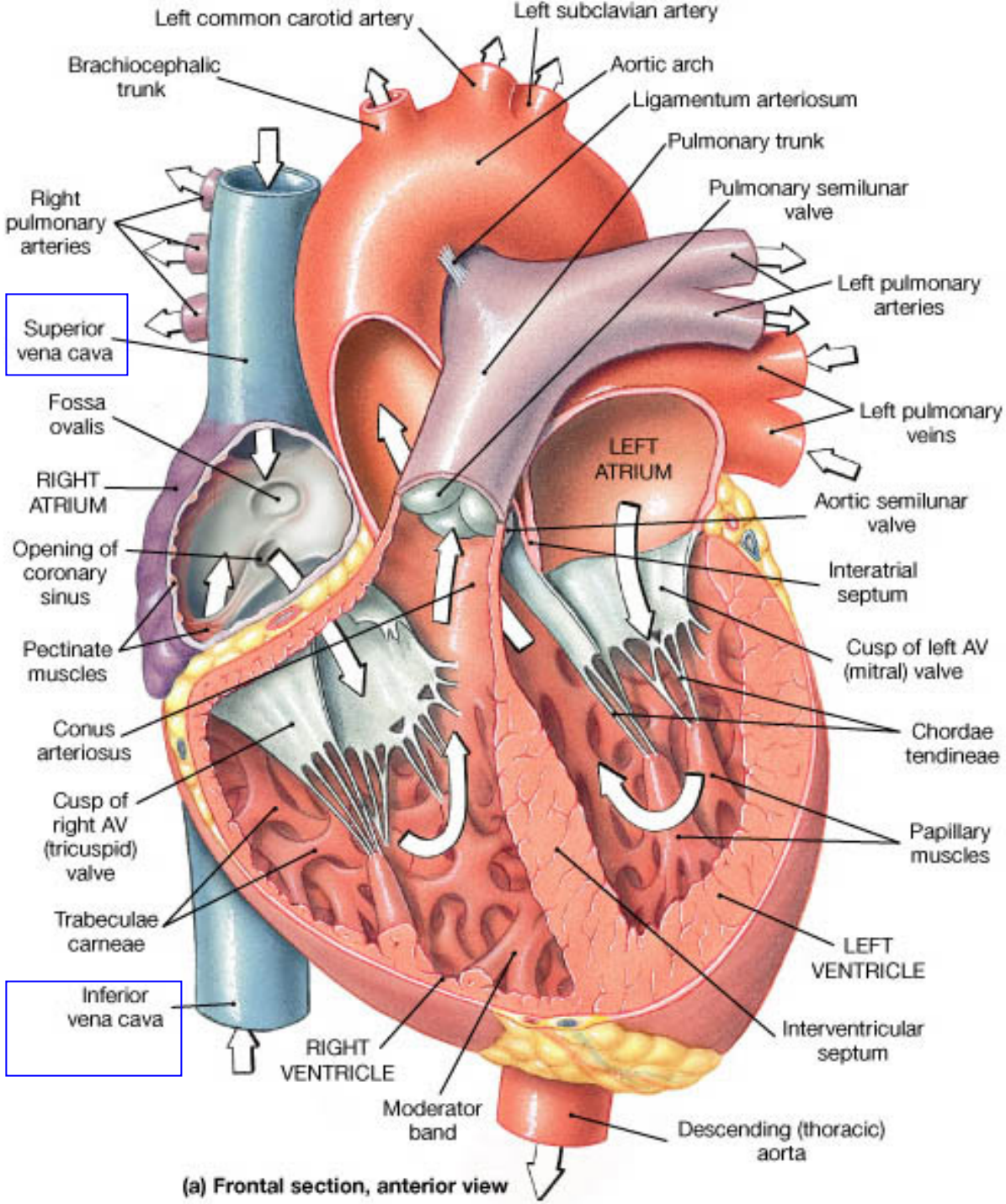
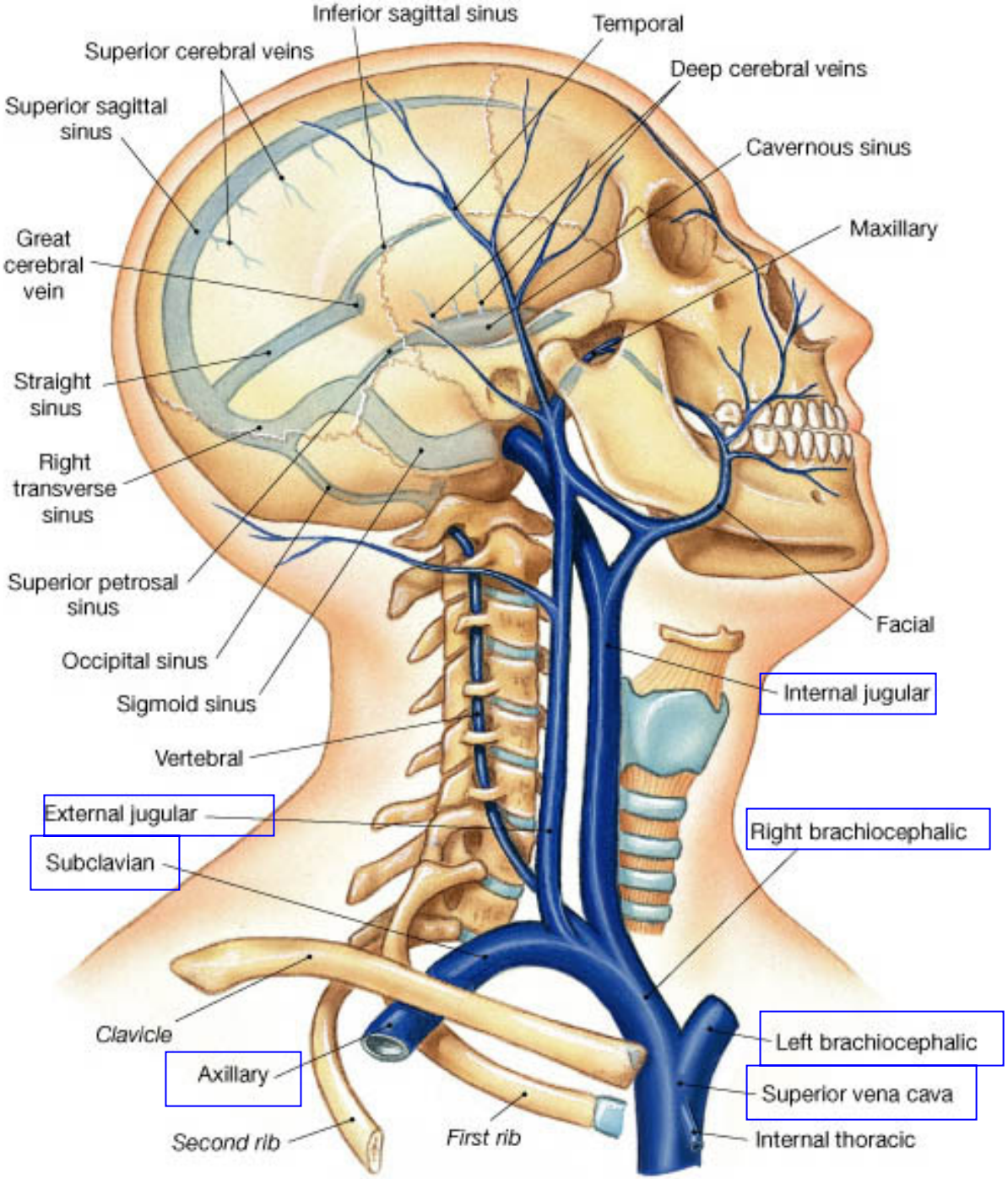
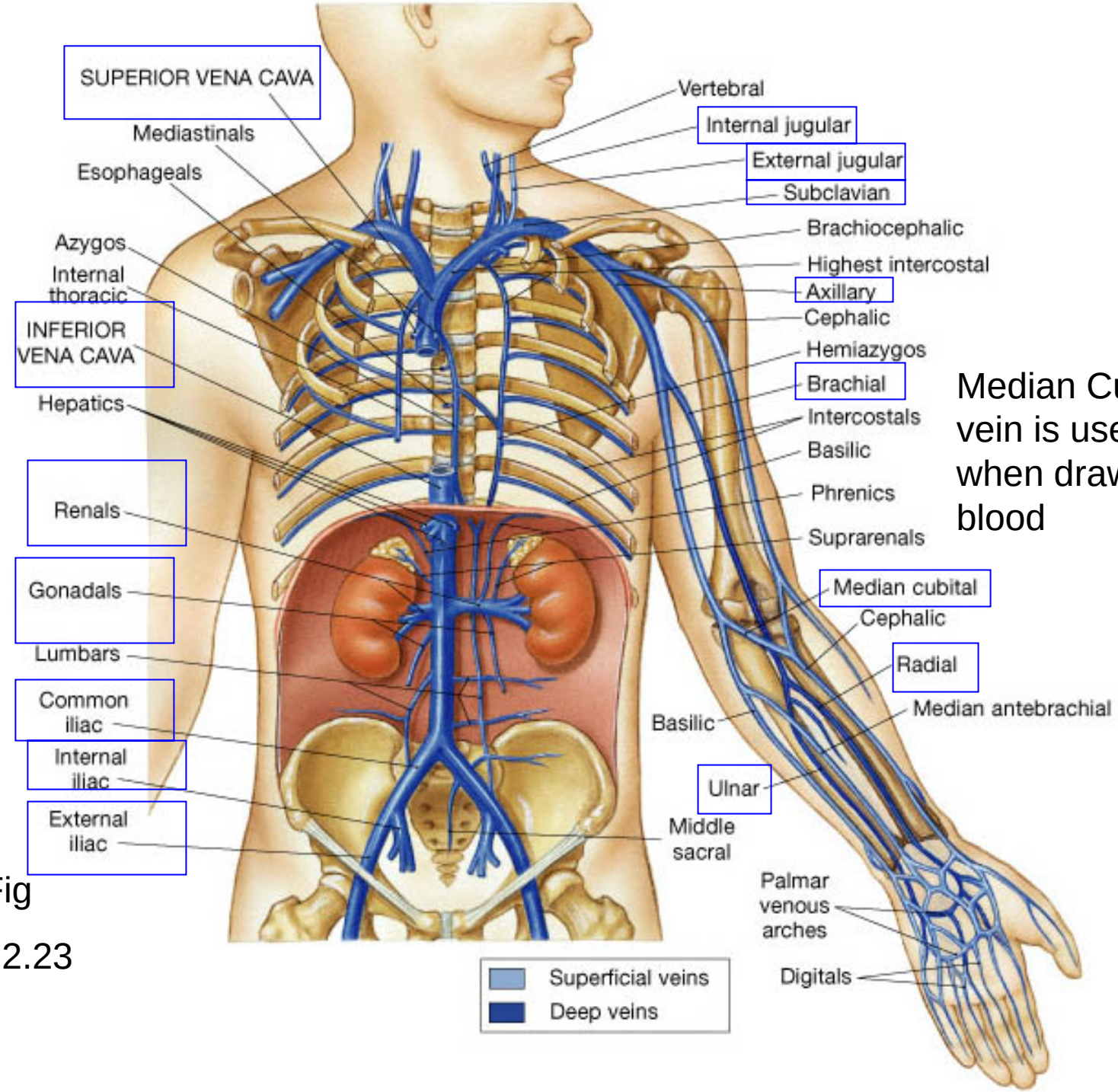

Left common carotid artery
Left subclavian artery
Brachiocephalic trunk
Aortic arch
Ligamentum arteriosum
Pulmonary trunk
Pulmonary semilunar valve
Right pulmonary arteries
Left pulmonary arteries
Superior vena cava
Fossa ovalis
Left pulmonary veins
LEFT ATRIUM
RIGHT ATRIUM
Aortic semilunar valve
Opening of coronary sinus
Interatrial septum
Pectinate muscles
Cusp of left AV (mitral) valve
Conus arteriosus
Chordae tendineae
Cusp of right AV (tricuspid) valve
Papillary muscles
Trabeculae carneae
LEFT VENTRICLE
Inferior vena cava
Interventricular septum
RIGHT VENTRICLE
Moderator band
Descending (thoracic) aorta
(a) Frontal section, anterior view

Fig 22.22

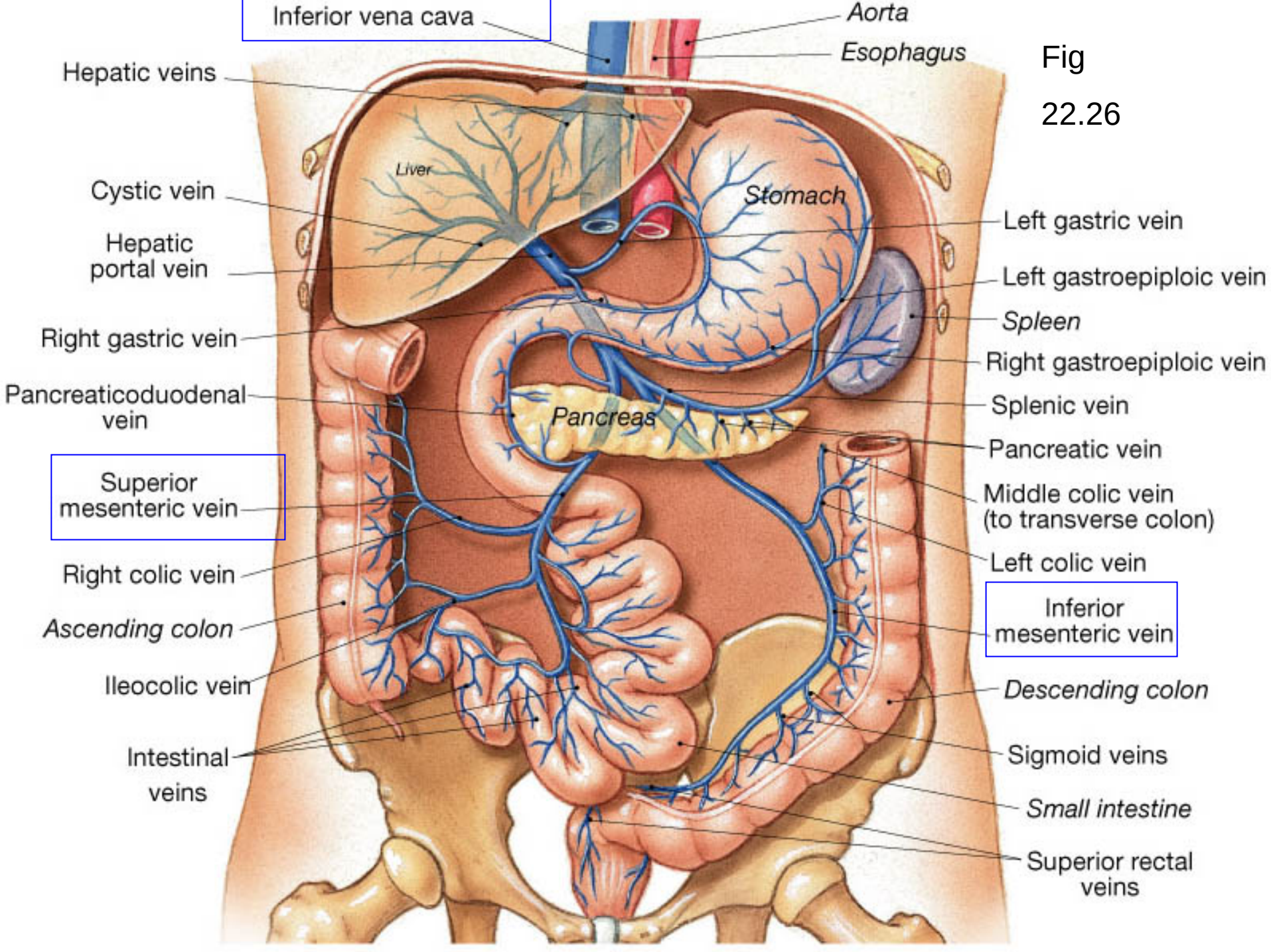


(a) Veins of the head and neck, lateral view



Median Cubital vein is used when drawing blood

Fig 22.23


Inferior vena cava
Aorta
Esophagus
Hepatic veins
Liver
Stomach
Cystic vein
Hepatic portal vein
Left gastric vein
Left gastroepiploic vein
Spleen
Right gastric vein
Right gastroepiploic vein
Pancreaticoduodenal vein
Pancreas
Splenic vein
Pancreatic vein
Superior mesenteric vein
Middle colic vein (to transverse colon)
Left colic vein
Right colic vein
Inferior mesenteric vein
Ascending colon
Ileocolic vein
Descending colon
Intestinal veins
Sigmoid veins
Small intestine
Superior rectal veins

Fig

22.26

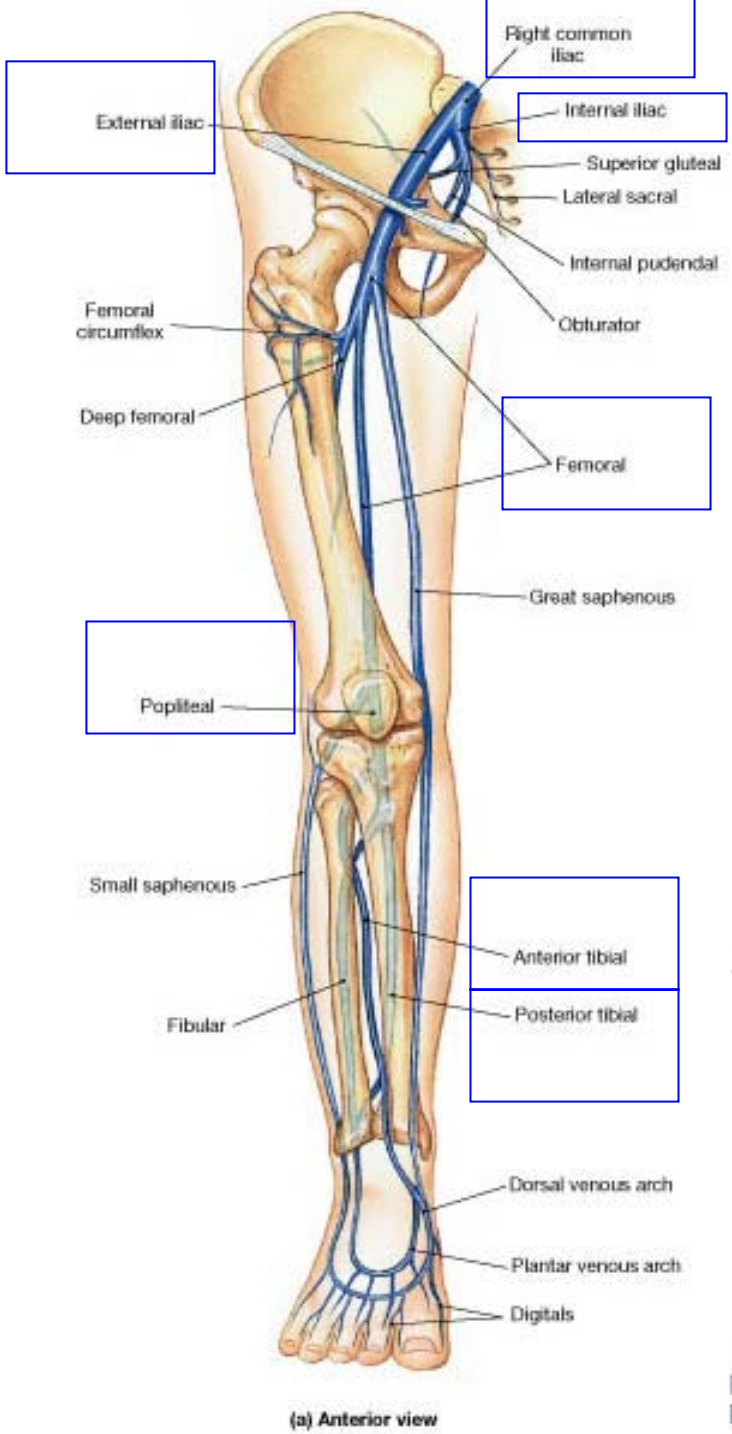
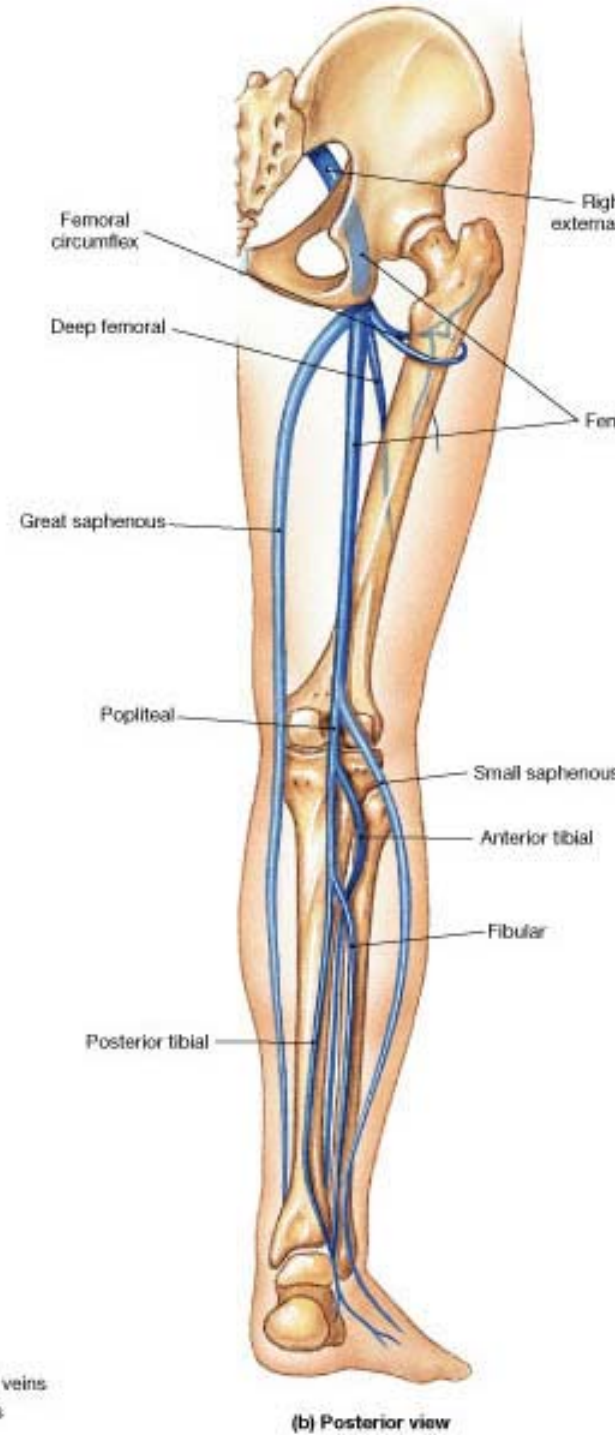

Right common iliac
External iliac
Internal iliac
Superior gluteal
Lateral sacral
Internal pudendal
Obturator
Femoral circumflex
Deep femoral
Femoral
Great saphenous
Popliteal
Small saphenous
Anterior tibial
Fibular
Posterior tibial
Dorsal venous arch
Plantar venous arch
Digitals
(a) Anterior view

Fig 22.25


Femoral circumflex
Deep femoral
Great saphenous
Popliteal
Small saphenous
Anterior tibial
Fibular
Posterior tibial
Superficial veins
Deep veins
(b) Posterior view