

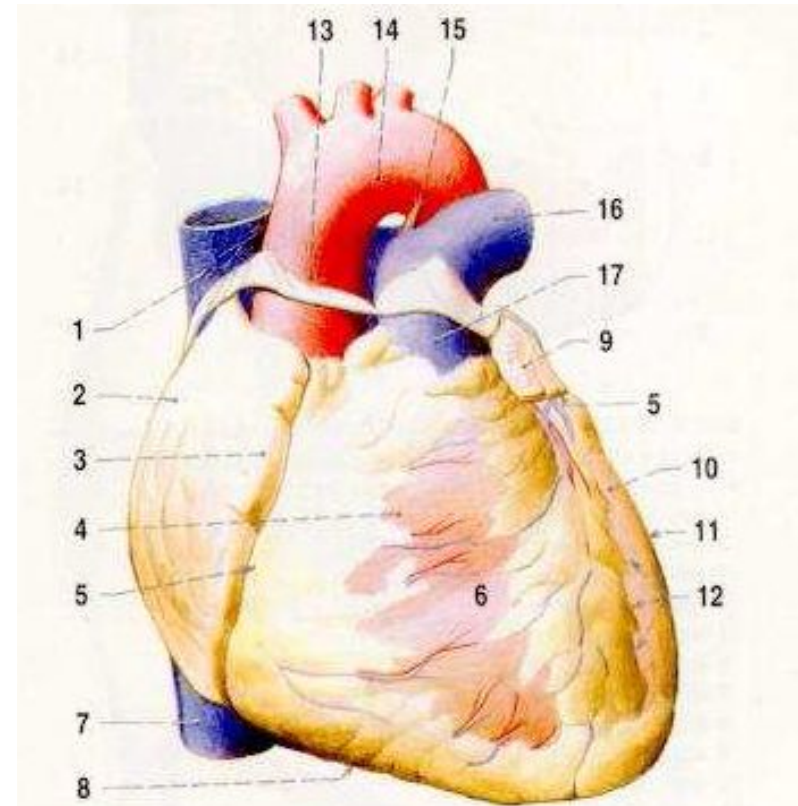
HEART

- hollow muscular organ
- drives blood by rhythmic contraction (systole) and relaxation (diastole)
 - arteries – cordifugal transport
 - capillaries – terminal network of blood vessels, wall consisting of a single layer of endothelial cells
 - veins – cordipetal transport
- heart completely divided into right and left parts by a septum (septum interatriale et interventriculare), which is visible on the surface as
 - sulcus interventricularis anterior et posterior
 - incisura apicis cordis
- facies sternocostalis, diaphragmatica et pulmonalis
- left margo obtusus et right – acutus
- basis et apex cordis
- auricula dextra et sinistra
- sulcus coronarius with the main trunks of the cardiac vessels
 - separates the atria from the ventricles
- atrium dx. et sin. (atrium) with auricles (auricula dx. et sin.)
 - thin-walled cavity
 - blood flows in from the veins
- ventriculus dx. et sin. (ventricle)
 - thick muscle walls
 - blood ejected into the arteries
 - inflow and outflow parts

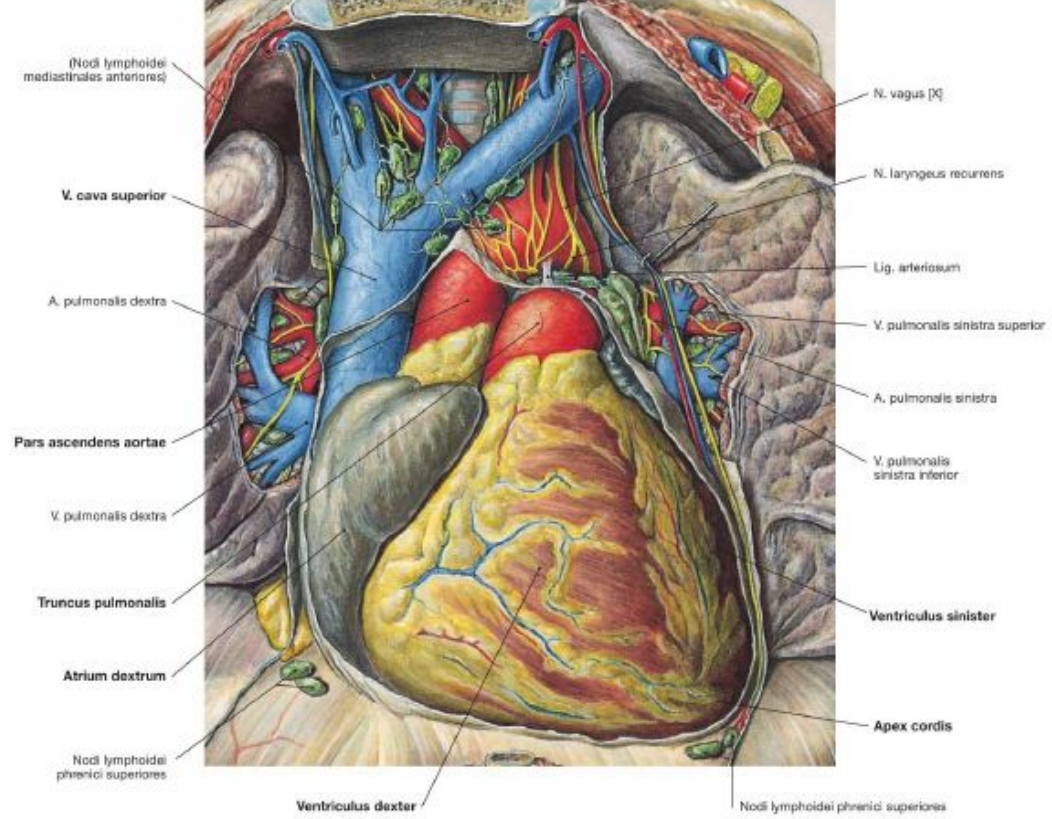
Obr. 8. SRDCE vyjmuté z perikardu; pohled zředu

- 1 vena cava superior
- 2 atrium dextrum
- 3 auricula dextra
- 4 ventriculus dexter
- 5 sulcus coronarius
- 6 facies sternocostalis
- 7 vena cava inferior
- 8 margo acutus

- 9 auricula sinistra
- 10 ventriculus sinister
- 11 margo obtusus
- 12 sulcus interventricularis anterior
- 13 aorta ascendens
- 14 arcus aortae
- 15 ligamentum arteriosum
- 16 arteria pulmonalis sinistra
- 17 truncus pulmonalis

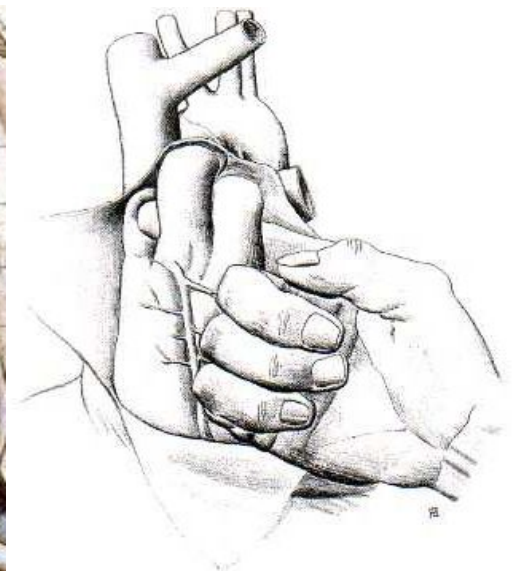


HEART



HEART

- stored in the pericardium
 - lamina parietalis (pericardium sensu stricto) – thin shiny membrane
 - lamina visceralis = epicardium, fused with the surface of the heart
- epicardium ←
 - serous coating
 - subepicardial connective tissue – in places with fatty connective tissue
- myocardium
 - transversely striated cardiac muscle
- endocardium
 - a single layer of endothelial cells supported by connective tissue
 - lines the interior of the heart



PERICARDIUM

pericardium serosum

- pericardium serosum
- double layer surrounding the heart, inside cavitas pericardialis with a small amount of liquor pricardii
- lamina parietalis pericardii – pericardium in the narrower sense
- transition to the visceral layer:
 - porta arteriarum
 - porta venarum
 - sinus transversus pericardii
 - sinus obliquus pericardii
- cupula pericardii
 - recessus aorticus
 - recessus pulmonalis

pericardium fibrosum

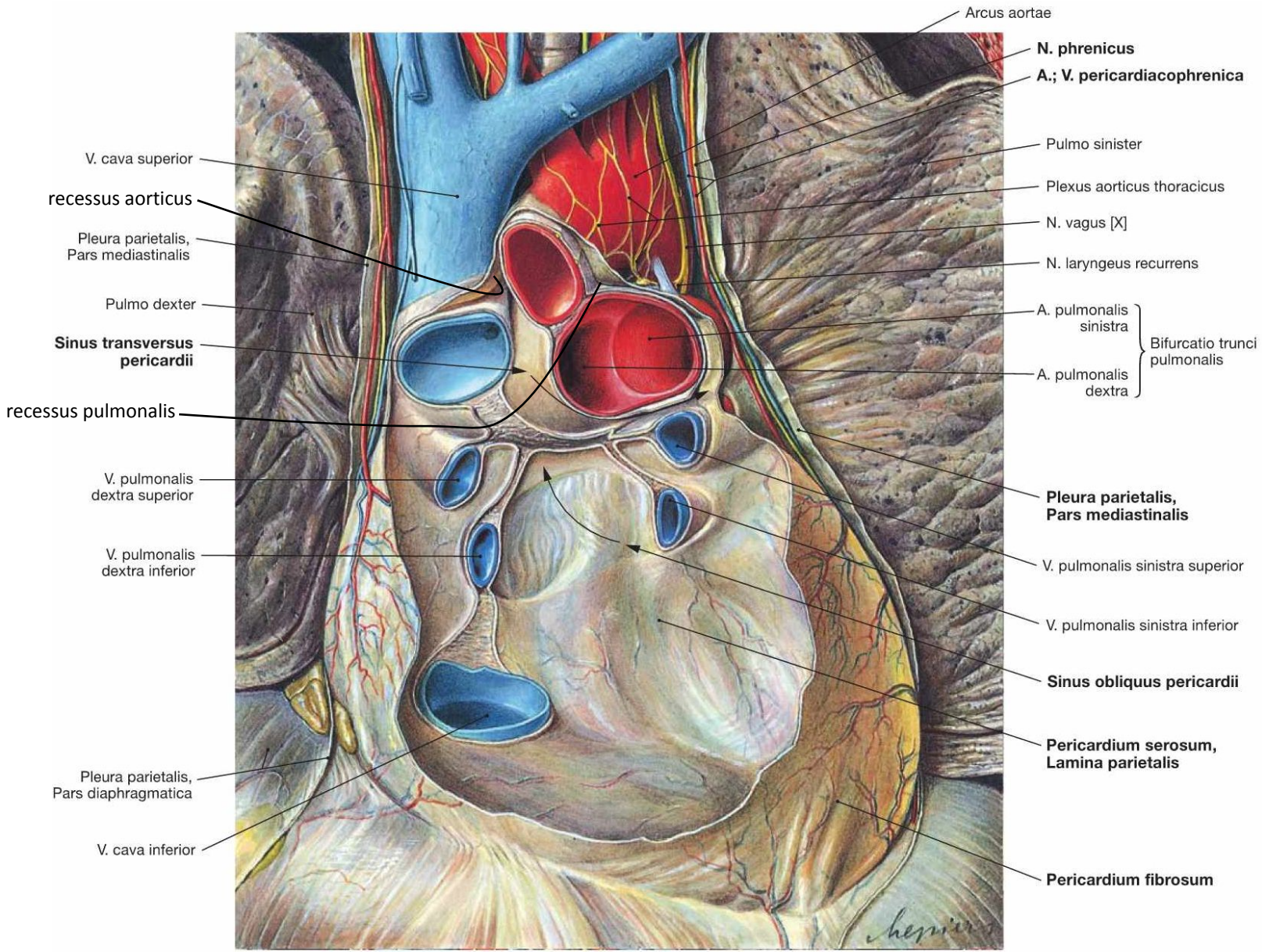
- dense connective tissue adjacent to the outside of the lamina parietalis pericardii
- attaches to the centrum tendineum diaphragmatic
- area pericardiaca – point of contact between the pericardium and the anterior wall of the thorax



The pericardium transitions into the epicardium via:

- a) the aorta and pulmonary trunk as the porta arteriarum
- b) the veins entering the heart as the porta venarum
- c) the sinus transversus pericardii between the portas

PERICARDIUM

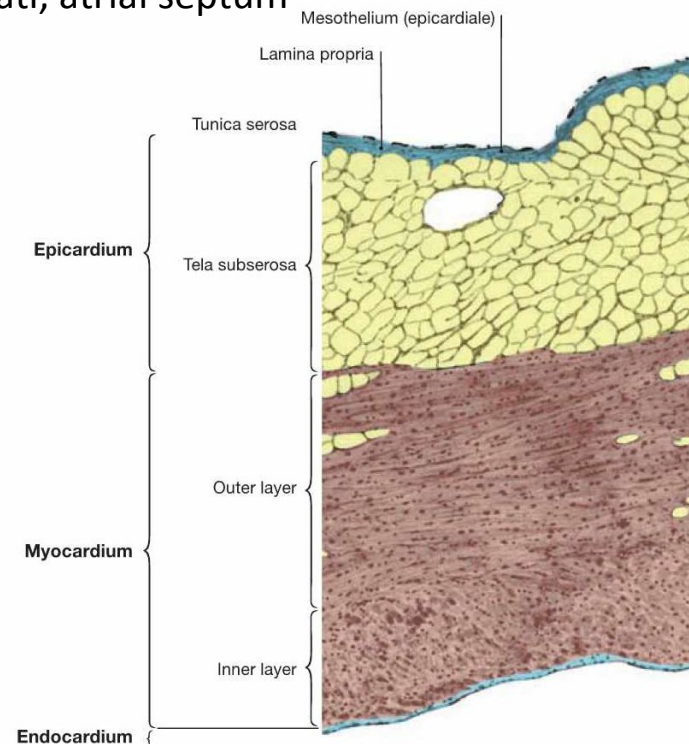
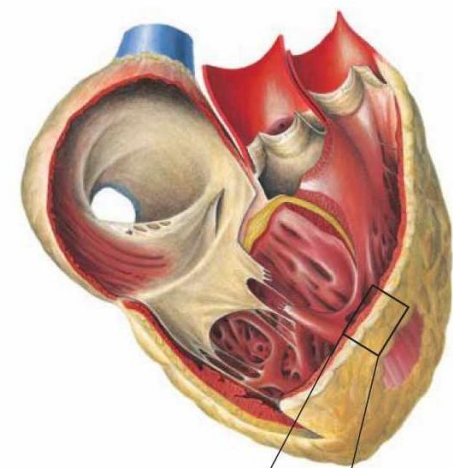


V. cava superior
 recessus aorticus
 Pleura parietalis,
 Pars mediastinalis
 Pulmo dexter
**Sinus transversus
 pericardii**
 recessus pulmonalis
 V. pulmonalis
 dextra superior
 V. pulmonalis
 dextra inferior
 Pleura parietalis,
 Pars diaphragmatica
 V. cava inferior

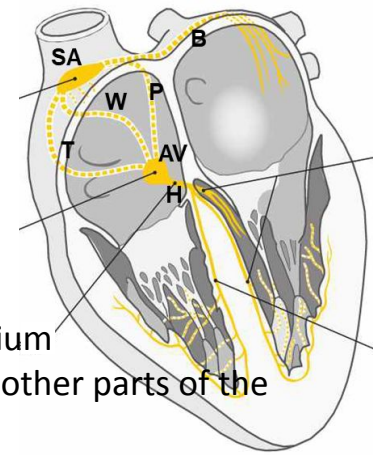
Arcus aortae
N. phrenicus
A.; V. pericardiophrenica
 Pulmo sinister
 Plexus aorticus thoracicus
 N. vagus [X]
 N. laryngeus recurrens
 A. pulmonalis
 sinistra }
 Bifurcatio trunci
 pulmonalis
 A. pulmonalis
 dextra }
**Pleura parietalis,
 Pars mediastinalis**
 V. pulmonalis sinistra superior
 V. pulmonalis sinistra inferior
Sinus obliquus pericardii
**Pericardium serosum,
 Lamina parietalis**
Pericardium fibrosum

LAYERS OF THE HEART WALL

- (pericardium)
- epicardium (lamina visceralis pericardii)
 - serous coating of the heart surface
 - arteries, veins, and nerves of the heart run through connective tissue and adipose tissue (connection to the myocardium)
- myocardium
 - varying thickness in different parts of the heart
 - the cardiac skeleton separates the myocardium of the atria from the myocardium of the ventricles; the only connection is provided by the atrioventricular node
 - deep layer – arches and circles, mm. pectinati, atrial septum
 - surface layer – longer transverse stripes
- endocardium
 - single layer of endothelial cells
 - connective tissue lamina propria
 - subendocardial loose connective tissue (connects the myocardium)

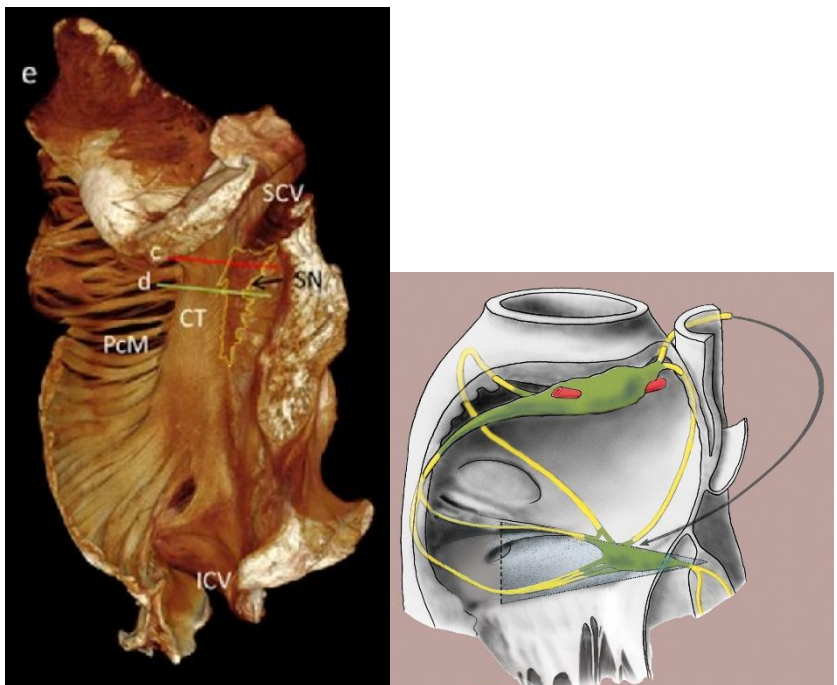


CONDUCTING SYSTEM OF HEART

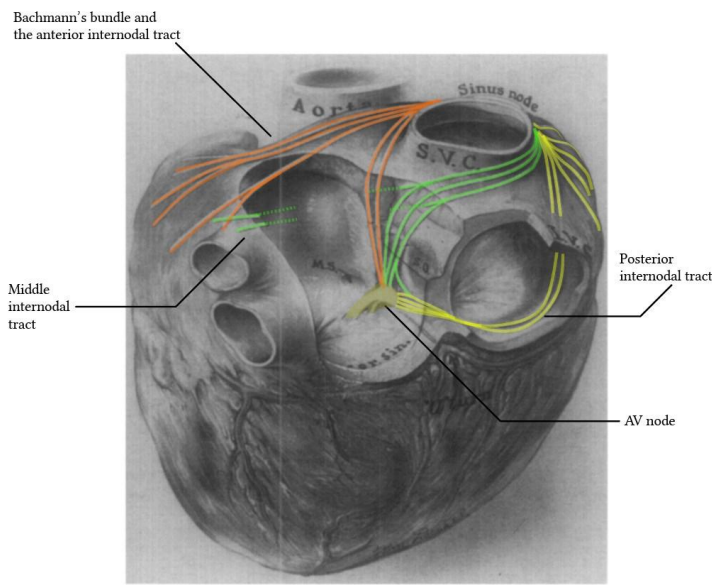
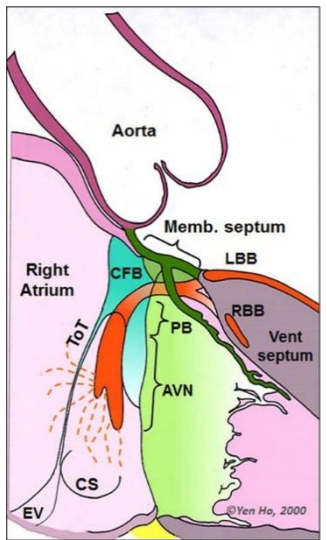
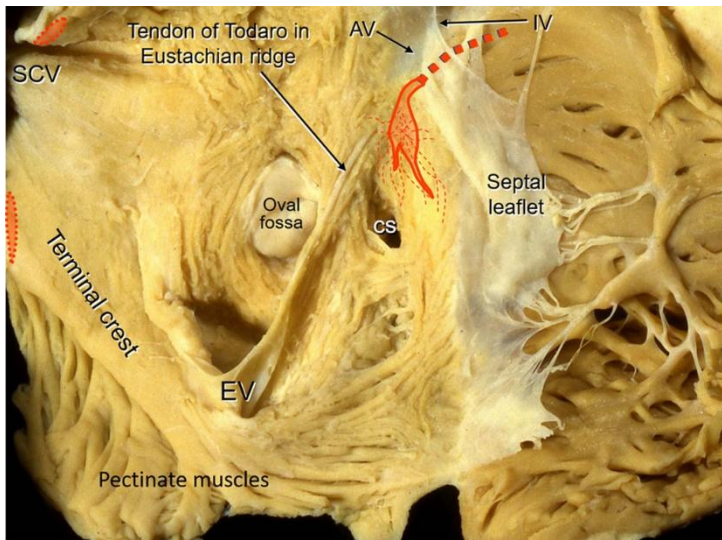


- sinus node (SA)
 - between the opening of the v. c. s. and the right auricle to the crista terminalis
 - sinus node artery from the right coronary artery
 - heart pacemaker
 - nodal myocytes – probably the source of rhythmic activity
 - transitional type myocytes – slowly conduct impulses to Purkinje fibers or working myocardium
 - Purkinje fiber-type myocytes – rapidly conduct impulses to the working myocardium and to other parts of the conduction system
- atrioventricular node (Aschoff-Tawar, AV)
 - caudal to the fossa ovalis, anterior to the opening of the coronary sinus, just dorsal to the attachment of the septal leaflet of the tricuspid valve, pressing on the left annulus fibrosus from the left, surrounded by Todor's tendon
 - slows the signal from the SA (by 0.09 s) so that the atria can empty before ventricular systole
- connections from the sinoatrial node to the atrioventricular node and to the myocardium
 - anterior internodal bundle (P) – interatrial septum
 - interatrial bundle (Bachmann's bundle, B) – to the myocardium of the left atrium
 - middle internodal bundle (Wenckebach's bundle, W) posterior internodal bundle (Thorel's bundle, T) – crista terminalis
 - collateral fibers (bypass fibers) – fibers of the T bundle that go directly to the H bundle
 - accessory atrioventricular bundles
- fasciculus atrioventricularis (His bundle, H)
 - it emerges from the anterior edge of the atrioventricular node and passes through the right fibrous triangle to the posterior edge of the membranous part of the interventricular septum, from where it continues caudally into the muscular part of the septum, where it divides into the crus (see below)
- right and left crus of the atrioventricular bundle (left and right Tawar branches)
 - pass through the ventricular septum to the bases of the adjacent papillary muscles
 - crus dextrum into the trabecula septomarginalis to the base of the m. papilaris anterior, where it divides into Purkinje fibers
 - crus sinistrum consists of numerous bundles that branch into Purkinje fibers along the walls of the left ventricle
- rami subendocardiales – Purkinje fibers (Purkyně, 1845)

CONDUCTING SYSTEM OF HEART



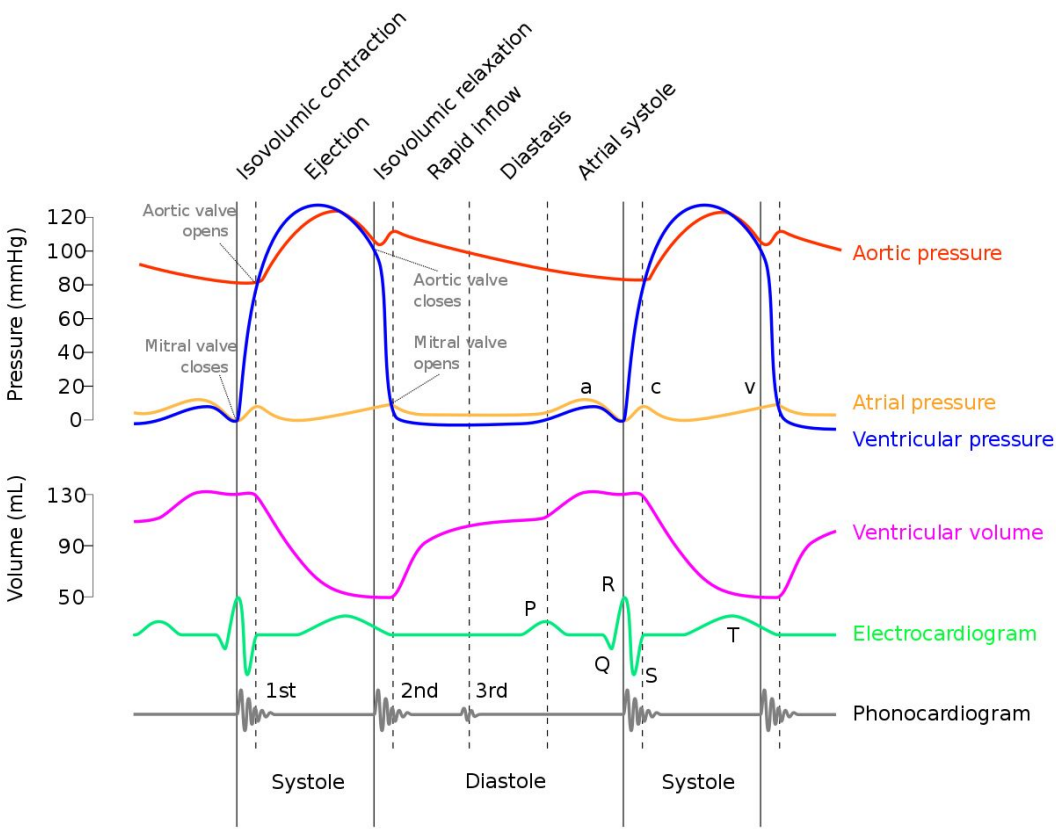
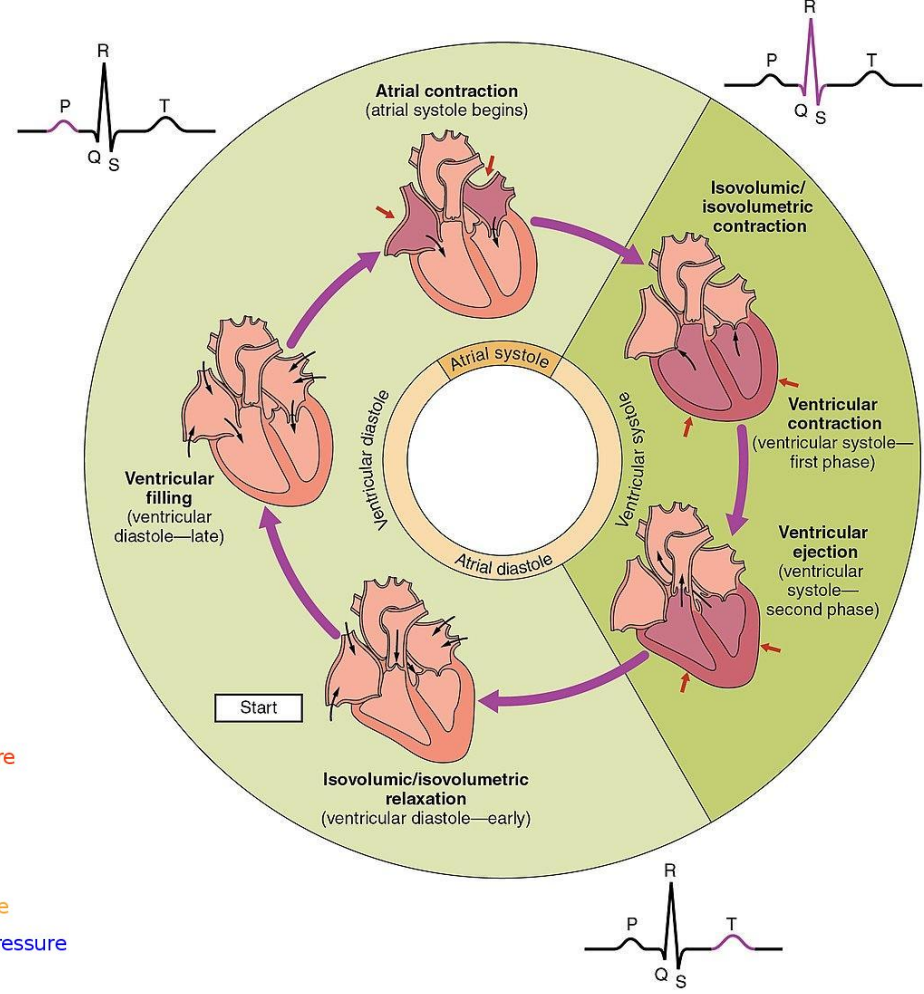
- individual openings and the fibroelastic fossa ovalis separate the atrial myocardium into relatively narrow bundles
- the isotropic orientation and thickening of myocardial fibers thus conducts electrical signals more quickly
- there is no other morphological evidence for internodal bundles.



HEART ACTIVITY

1. myocardial contraction waves progress from the venous openings through the atria to the atrioventricular openings
2. the impulse is transmitted to the apex cordis (the electrical signal "jumps" to the apex)
3. the contraction wave travels through the ventricular walls to the arterial openings (from the apex)
 - asynchronously on the left and right
 - systole of the right atrium precedes the left, systole of the left ventricle precedes the right
 - dependence on the phase of the respiratory cycle
 - equalization of blood volumes in the large and small circulations occurs through connections between the pulmonary circulation (functional) and the bronchial circulation (nutritive)
 - systole – contraction of the heart muscle
 - blood from the atria to the ventricles, closure of the atrioventricular valves, opening of the semilunar valves, ejection of blood
 - atrial systole, ventricular systole
 1. isovolumetric contraction (0.05 s) – slight shortening of the ventricular muscle increases pressure in the ventricles, closing the atrioventricular valves, while the semilunar valves remain closed
 2. ventricular ejection (0.22 s) – diastolic pressure in the ventricles exceeds that in the aorta or pulmonary trunk, causing the semilunar valves to open
 - diastole
 - closure of the semilunar valves, opening of the atrioventricular valves, blood fills the atria and ventricles
 - simultaneously in the atria and ventricles
 1. protodiastole (0.04 s) – rapid drop in pressure in the ventricles below the pressure in the aorta or pulmonary trunk, causing the semilunar valves to close
 2. isometric relaxation of the ventricular muscle (0.07 s) – pressure in the ventricles drops below the pressure in the atria, causing the atrioventricular valves to open
 3. passive filling of the ventricles (0.36 s)
 - valve closure is always accompanied by a sound – a heart sound
 - first heart sound – closure of the atrioventricular valves at the beginning of ventricular systole
 - second heart sound – closure of the semilunar valves at the beginning of diastole

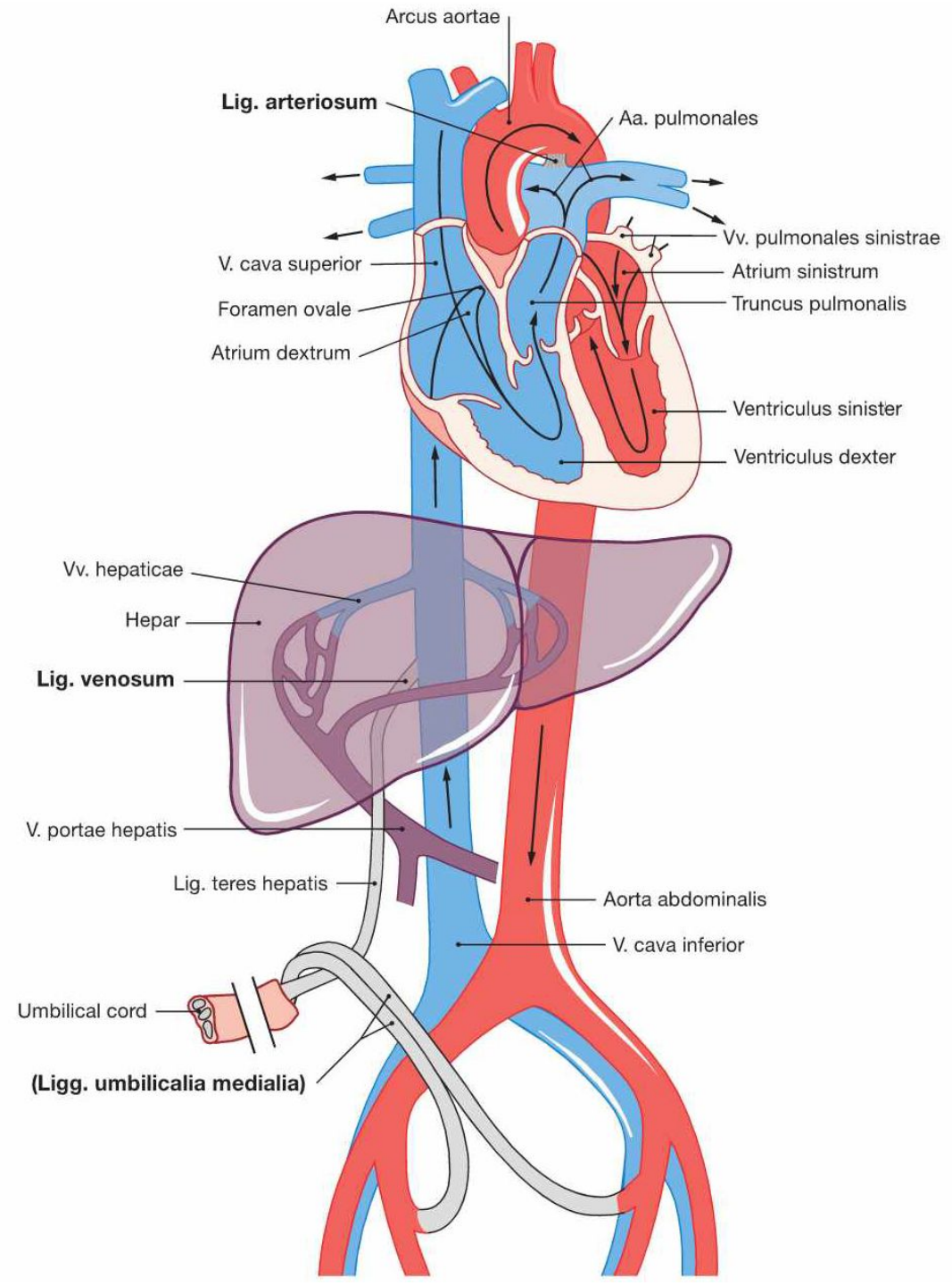
HEART ACTIVITY



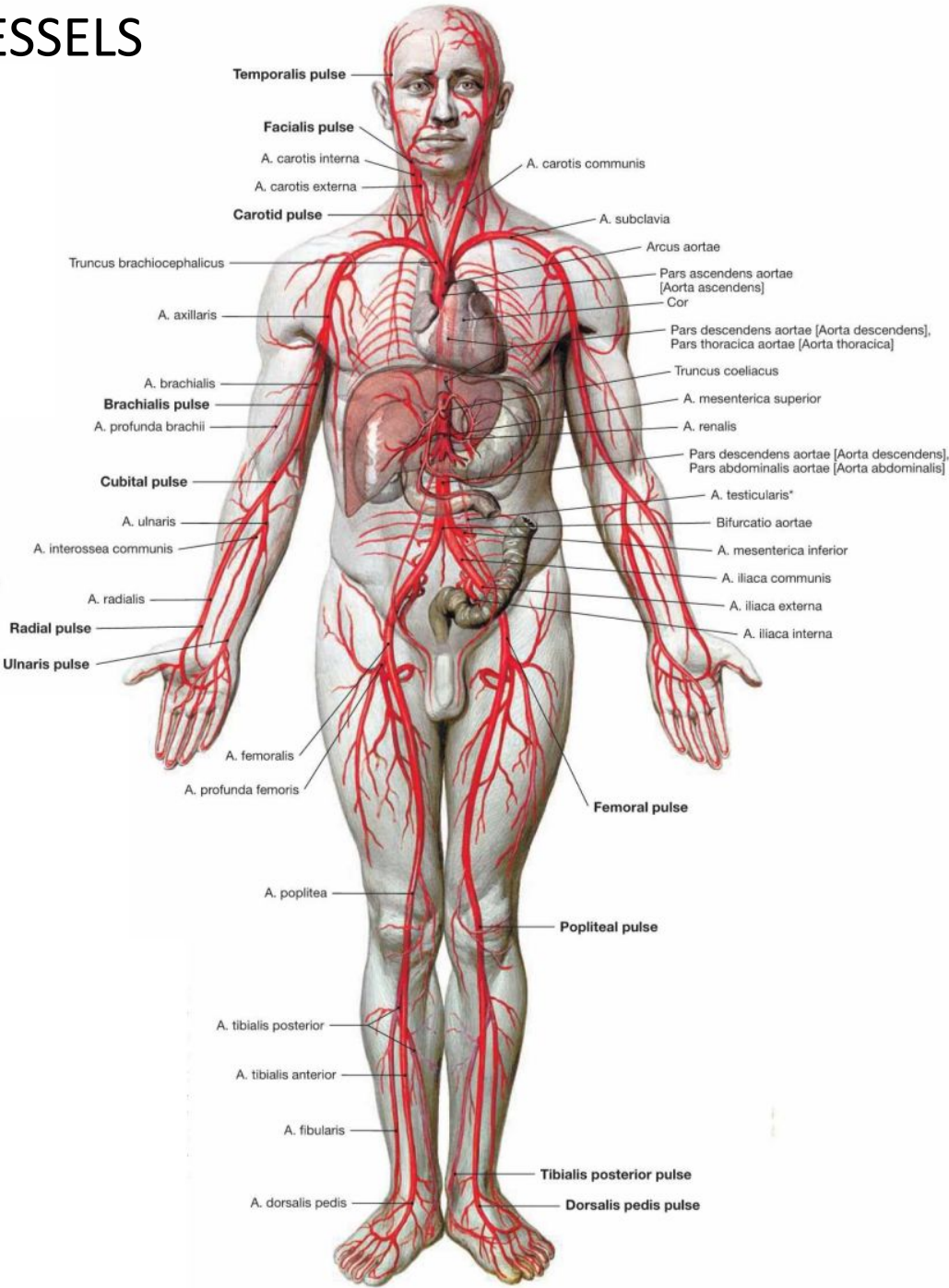
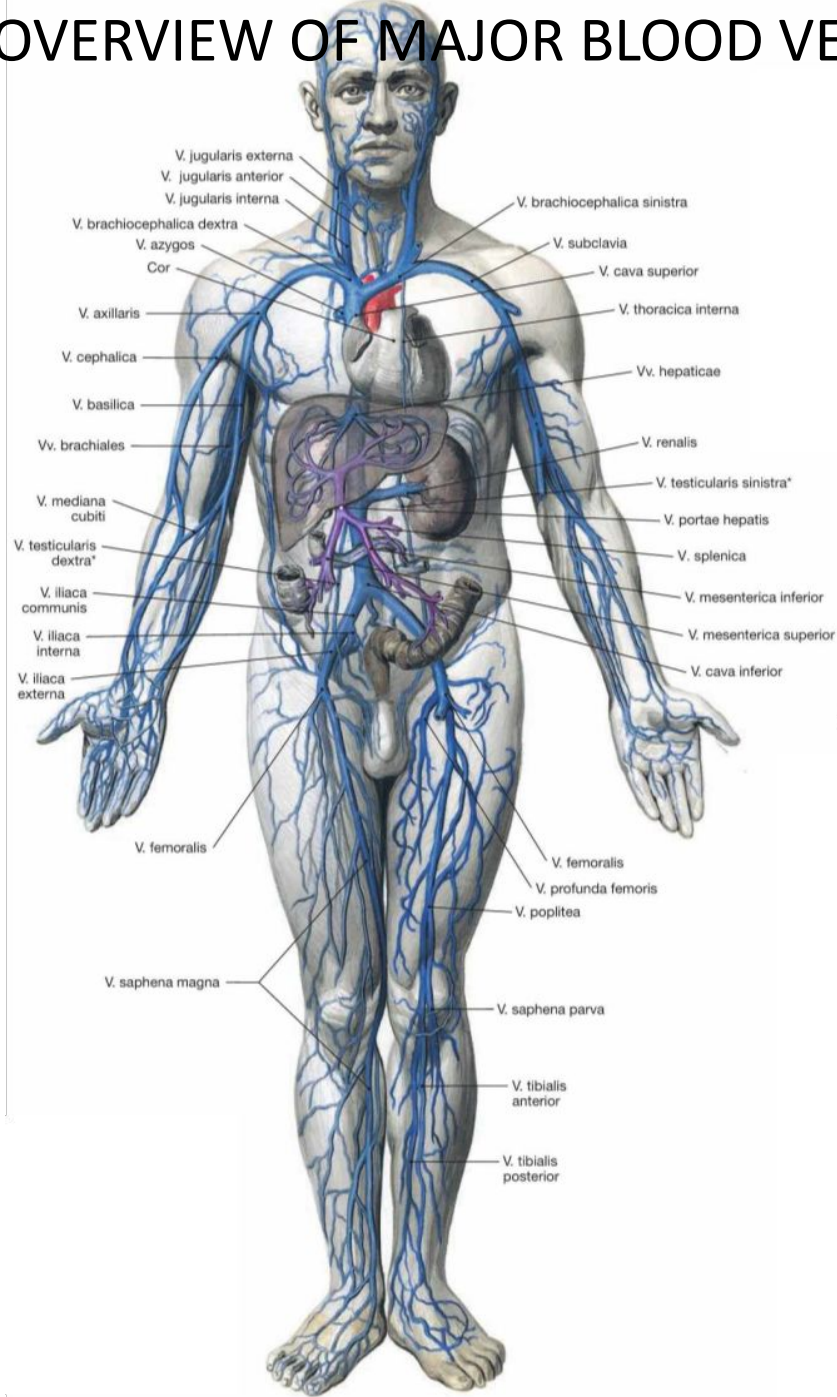
CIRCUITUS SANGUINIS

circuitus sanguinis minor

- v. cava superior et inferior (low O₂)
- atrium dx.
- ventriculus dx.
- truncus pulmonalis → a. pulmonalis
- lungs (~O₂)
- vv. pulmonales dextrae et sinistrae
- atrium sin.
- ventriculus sin.
- aorta
- capillaries
- v. cava superior et inferior

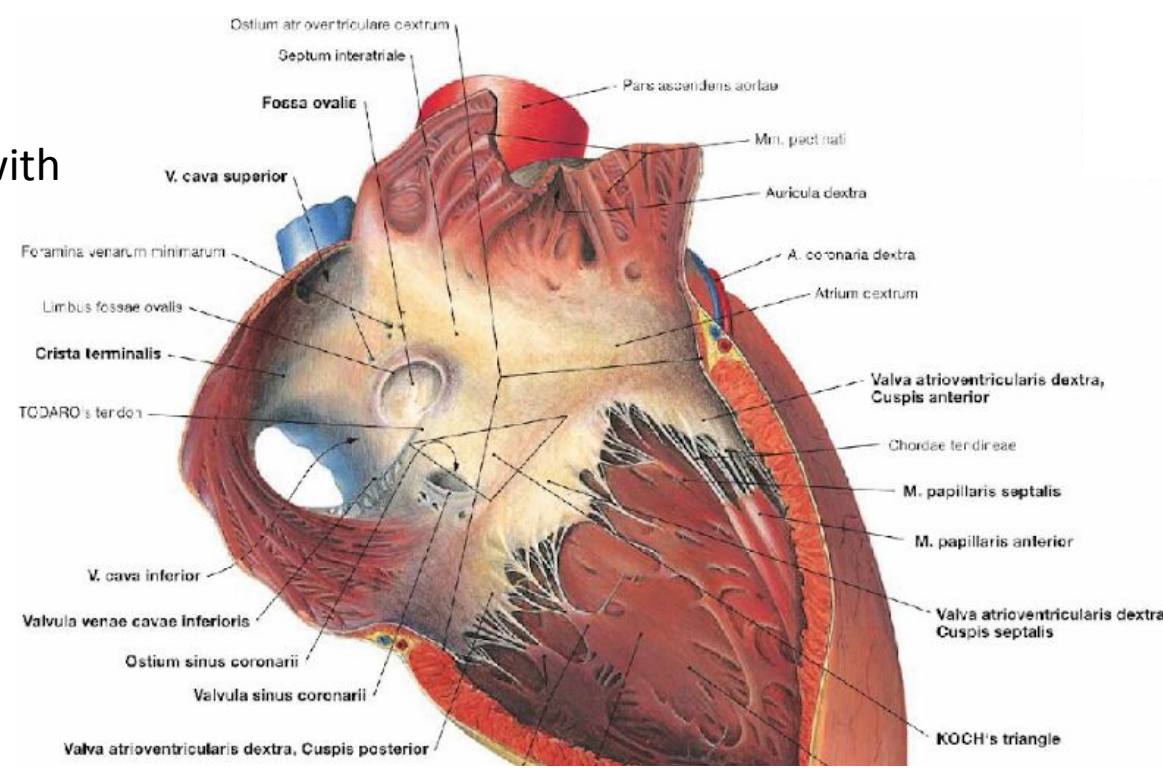


OVERVIEW OF MAJOR BLOOD VESSELS



ATRIUM DEXTRUM

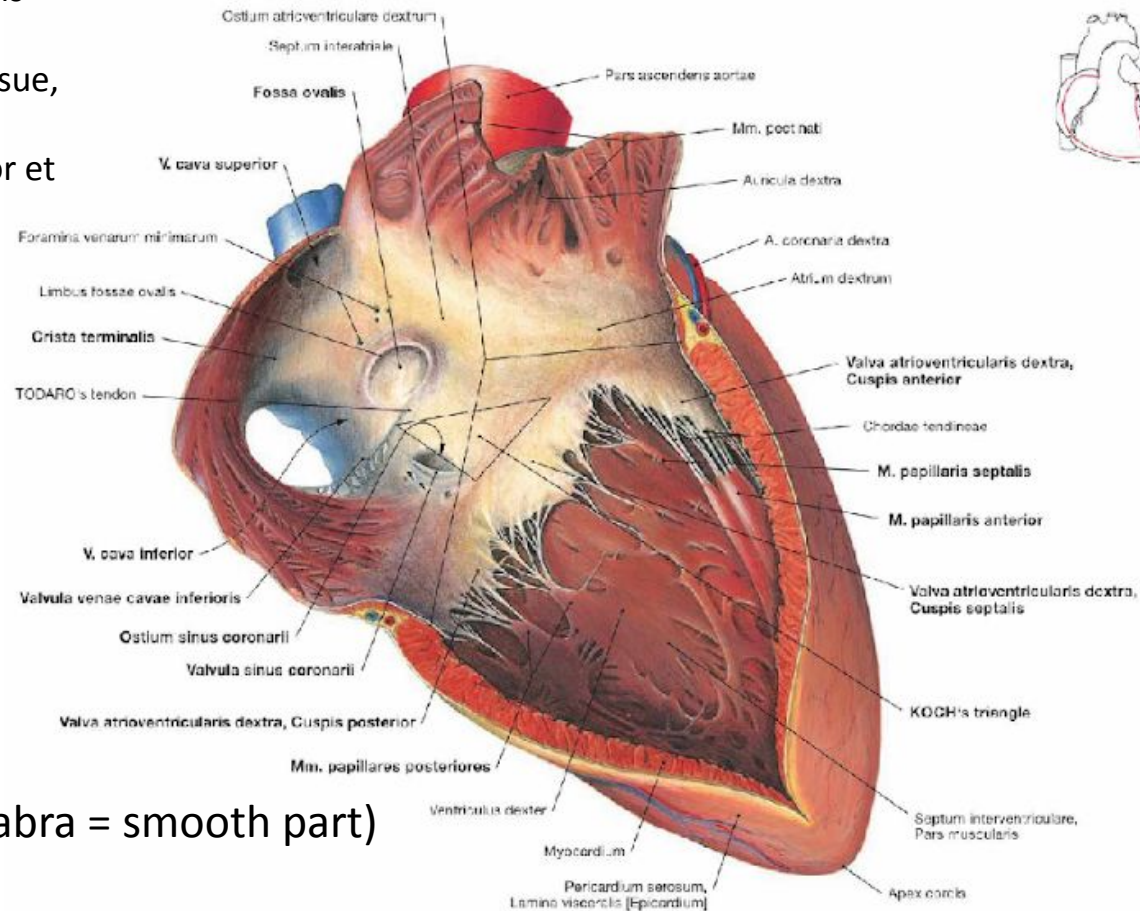
- ostium venae cavae superioris et inferioris
- sinus venarum cavarum
 - sulcus terminalis et crista terminalis
- tuberculum intervenosum – directs blood form the SVC
- valvula venae cavae inferioris – directs blood form the IVC } prevents turbulent flow
- auricula dextra with mm. pectinati
- septum interatriale with fossa ovalis and limbus fossae ovalis
- ostium sinus coronarii
- valvula sinus coronarii
- foramina venarum ventriculi dextri anteriorium
- foramina venarum minimarum
- ostium atrioventriculare dextrum with valva tricuspidalis



VENTRICULUS DEXTER

inflow part:

- ostium atrioventriculare dextrum s valva tricuspidalis
 - valva tricuspidalis (valva atrioventricularis dextra)
 - cuspides – endocard with connective tissue, cuspis anterior, posterior et septalis
 - muscoli papillares – m. papillaris anterior et posterior, mm. papillares septales
 - chordae tendinae
- trabeculae carnae

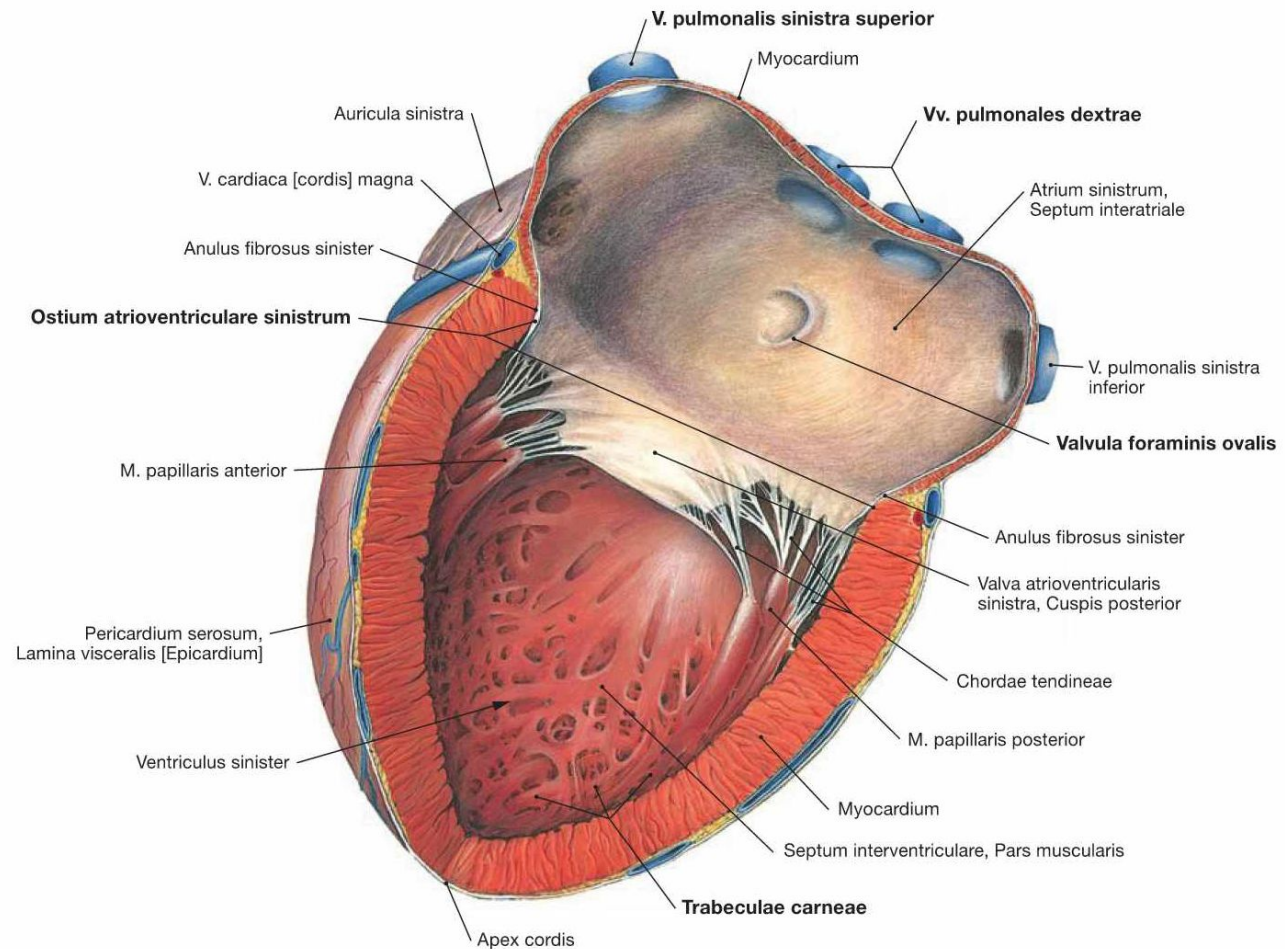


outflow part (conus arteriosus, pars glabra = smooth part)

- crista supraventricularis
- trabecula septomarginalis – crus dextrum of the cardiac conduction system passes through it
- ostium trunci pulmonalis with valva trunci pulmonalis
 - valvulae semilunares – anterior, dextra et sinistra
 - lunulae et noduli valvularum semilunarium

ATRIUM SINISTRUM

- ostia venarum pulmonalium
- auricula sinistra with mm. pectinati
- foramina venarum minimarum
- septum interatriale with valvula foraminis ovalis
- ostium atrioventriculare sinistrum



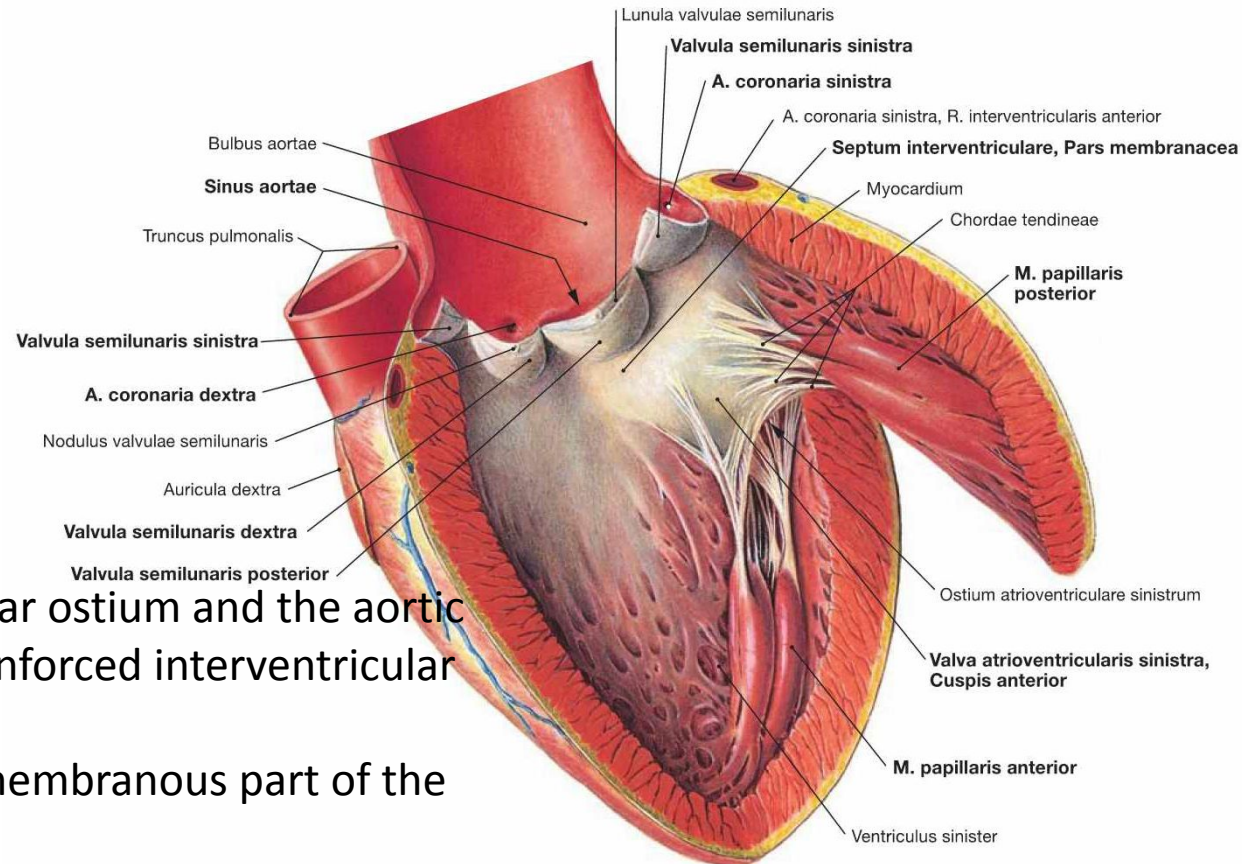
VENTRICULUS SINISTER

inflow part:

- left atrioventricular orifice with mitral valve
- mitral valve (right atrioventricular valve)
 - cusps – endocardial protrusions, anterior and posterior cusps and commissural cusps
- papillary muscles
 - anterior and posterior papillary muscles
 - tendinous chords
- trabeculae carnae

outflow part:

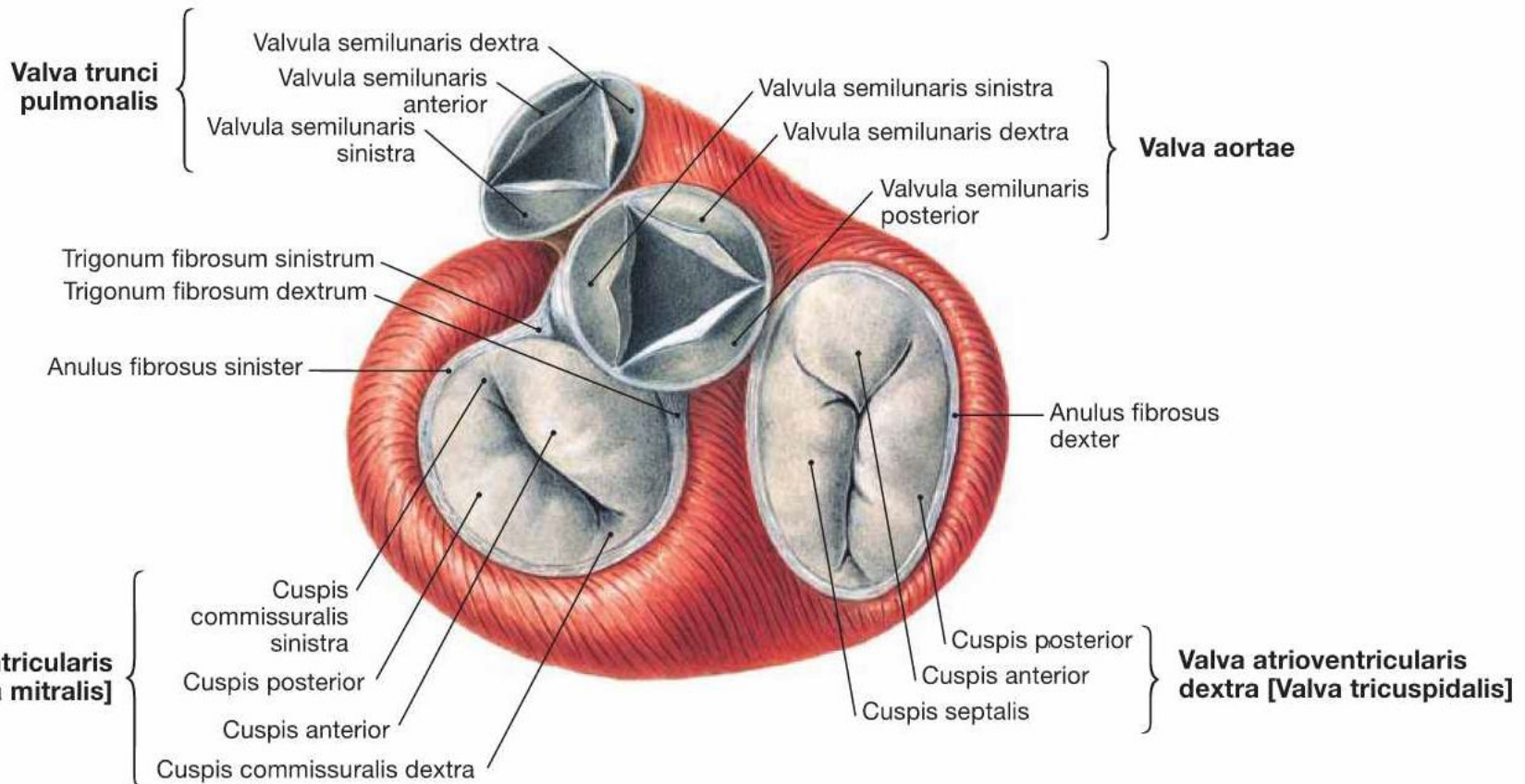
- ostium aortae s valva aortae
 - valvulae semilunares – posterior, dextra et sinistra
 - lunulae et noduli valvularum semilunarium
- the beginning of the aorta ascendens
 - sinus aortae dexter, sinister et posterior
 - arteria coronaria dextra et sinistra



- between the left atrioventricular ostium and the aortic ostium, a connective tissue-reinforced interventricular septum (aortic-mitral curtain)
- interventricular septum with membranous part of the interventricular septum

CARDIAC SKELETON

- supporting structure made of fibrous tissue located at all four heart valves
- anulus fibrosus dx. et sin., anulus aorticus, anulus trunci pulmonalis
- trigonum fibrosum dx. et sin.
- tendo infundibuli (conical tendon)
- pars membranacea septi



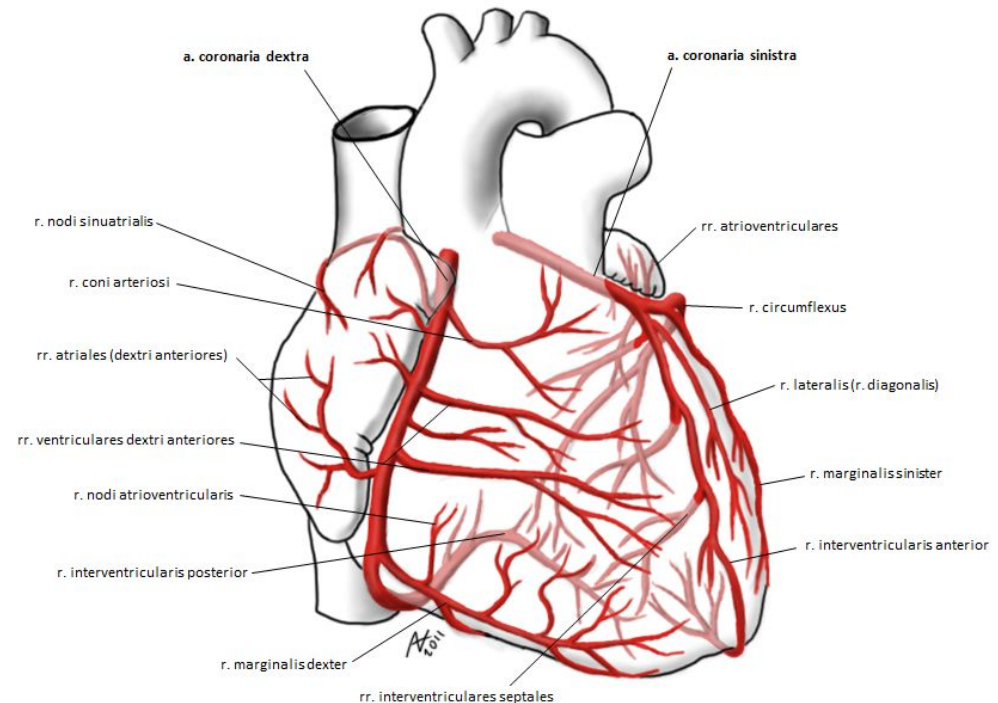
HEART ARTERIES

- aa. coronariae – nourishment of the heart walls
- wavy course
- when a branch of the coronary artery is occluded, the corresponding part of the myocardium is not supplied with oxygen
- dominance of a. coronaria dx./sin. – ramus interventricularis posterior
- right coronary artery
 - right ventricle wall, part of left ventricle, posterior third of interventricular septum, right atrium, part of left atrium, apex cordis
 - conduction system from sinoatrial node (approx. 53%) to proximal part of atrioventricular bundle
- left coronary artery
 - most of the left ventricle, right ventricle at the anterior interventricular sulcus, anterior two-thirds of the interventricular septum, apex cordis at the posterior part of the interventricular septum
 - sinus node (approx. 43%)functionally, the branches of the coronary arteries behave as terminal branches
 - both arteries – anterior papillary muscle of the right ventricle, posterior papillary muscle of the left ventricle
- anastomoses
 - smaller caliber (100–200 μm), under all layers of the heart, become more prominent with age
 - most commonly apex cordis, anterior and posterior interventricular sulcus
 - functionally insufficient

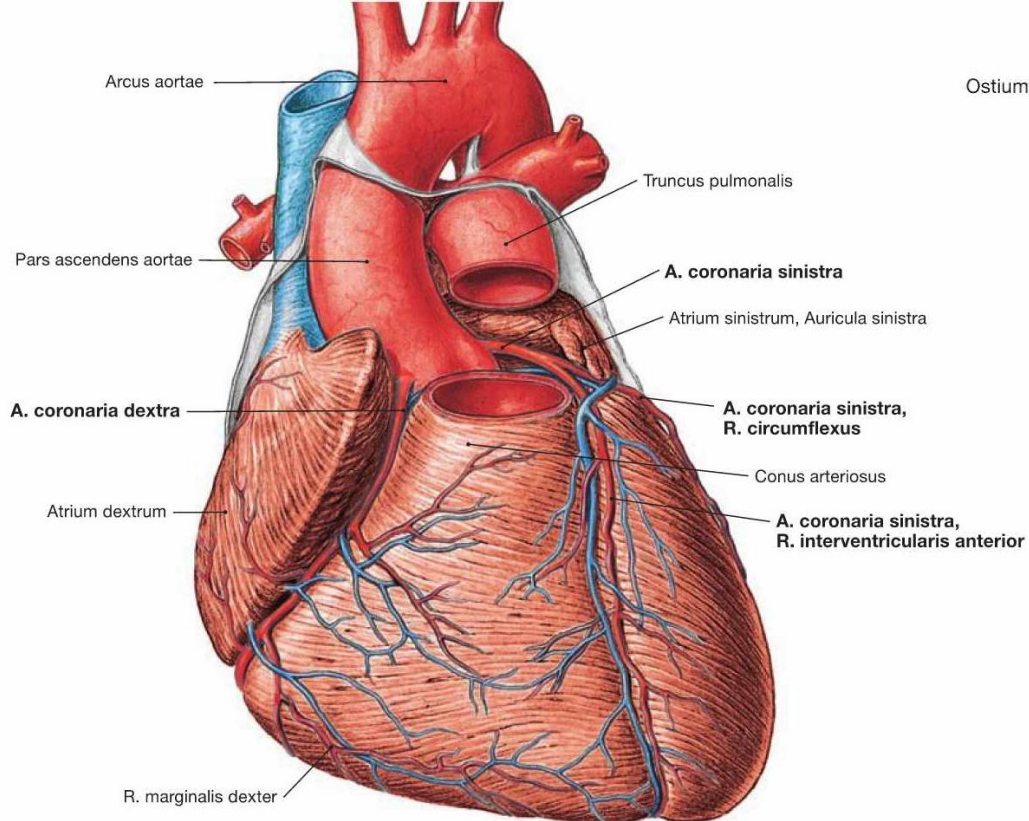
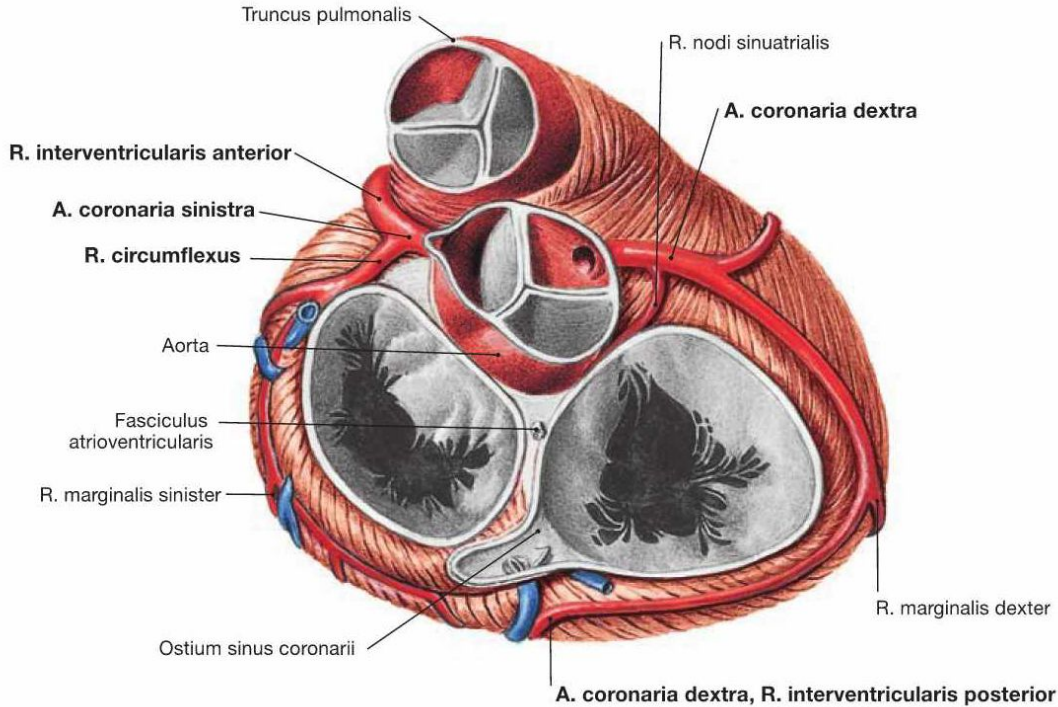
HEART ARTERIES

- a. coronaria dx.
- **trunk: originates from the sinus aortae dexter to the sulcus coronarius, ends as the ramus interventricularis posterior**
- rr. atriales
- rr. ventriculares dextri anteriores et posteriores – most prominent = **ramus marginalis dexter**
- **r. coni arteriosi** – frequent anastomosis with r. coni arteriosi a. coronariae sin. (Vieussens circle), in 36% it departs separately from sinus aortae dx.
- **r. nodi sinuatrialis** (also from the left) – most often runs between the right auricle and the beginning of the aorta
- r. interventriculares septales – branches from the posterior interventricular branch the most cranial one becomes the r. nodi atrioventricularis

- a. coronaria sin.
- **trunk: originates from the sinus aortae sinister, in 35% of cases gives rise to the ramus nodi sinuatrialis**
- **division of the trunk into:**
- **r. interventricularis anterior**
 - rr. ventriculares anteriores sinistri
 - rr. interventriculares septales
- **r. circumflexus**
 - rr. atrioventriculares
 - left marginal branch
 - atrial branches
 - posterior left ventricular branch



HEART ARTERIES

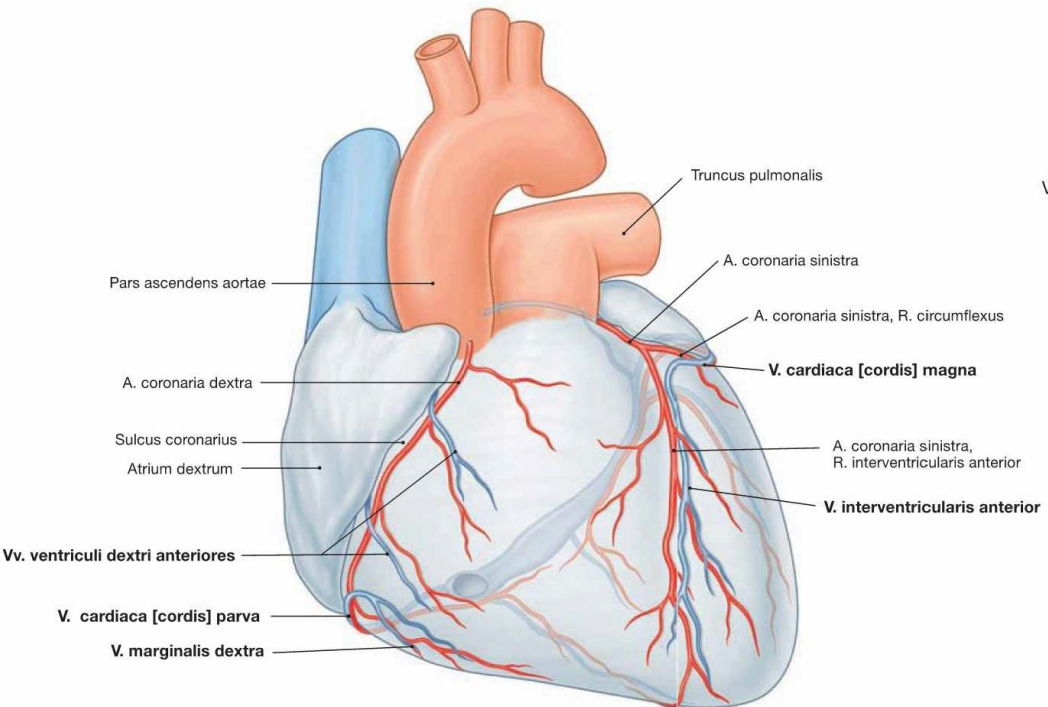
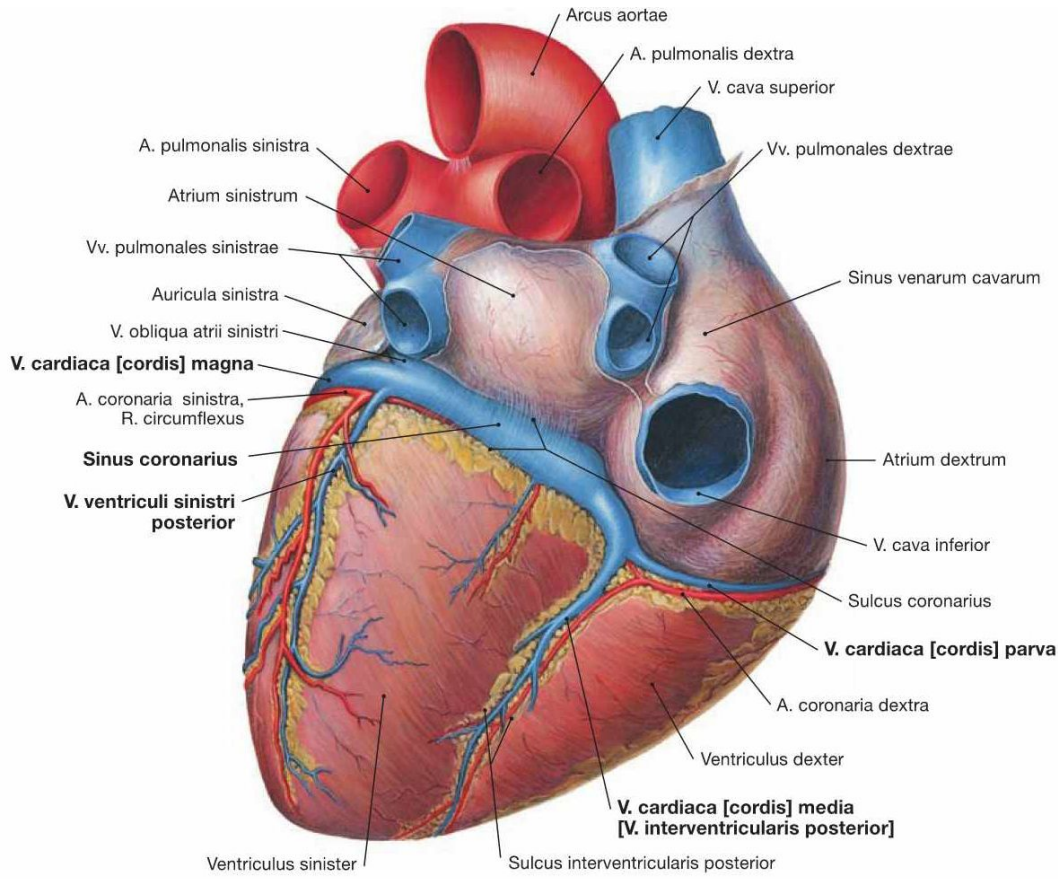


A. coronaria dextra, R. interventricularis posterior

HEART VEINS

- the valves may be located at the openings of the main trunks into the coronary sinus and into the v. cordis magna
- coronary sinus (approximately 60% of blood)
 - main collecting trunk, ostium sinus coronarii in the right atrium
 - v. cordis magna – from the anterior interventricular sulcus through the coronary sulcus to the coronary sinus, receives the posterior v. ventriculi sinistri and v. obliqua atrii sinistri (the inflow corresponds to the supply of the coronary artery)
 - v. cordis media – from sulcus interventricularis posterior to sulcus coronarius, empties into sinus coronarius (influx corresponds to supply of r. interventricularis posterior)
 - v. cordis parva – from margo acutus (v. marginalis dextra) through sulcus coronarius to sinus coronarius (blood from right and rear side of right ventricle)
- venae ventriculi dextri anteriores (vv. cordis anteriores) }
 - drain separately into the right atrium
- venae cordis minimae (Thebesii) } about 40% of blood
 - drain into all cavities
- anastomoses
 - more frequent
 - most often apex cordis, anterior and posterior walls of the ventricles
 - extracardiac – via vasa vasorum

HEART VEINS

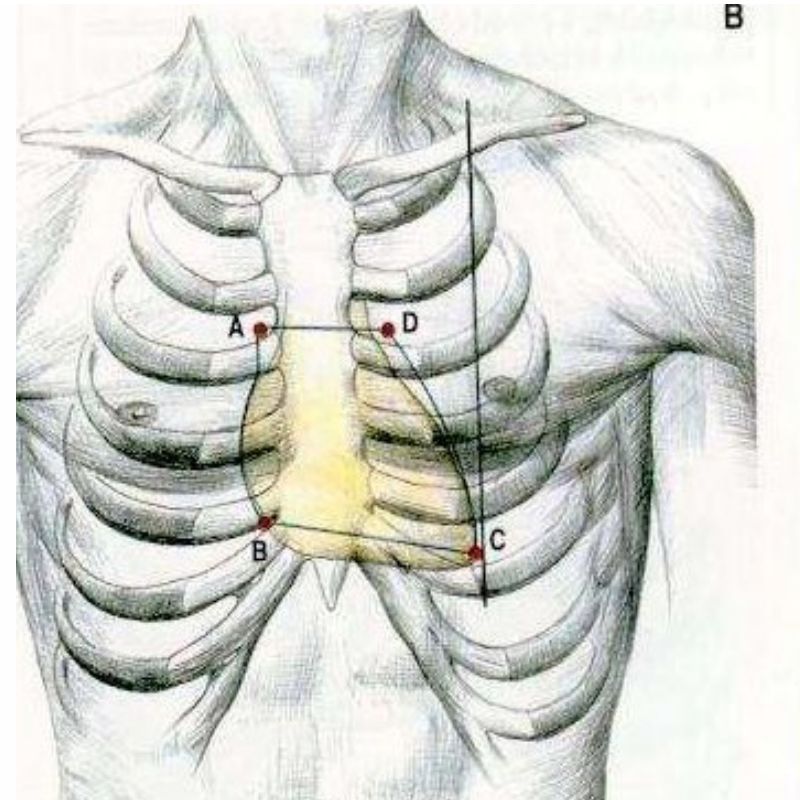
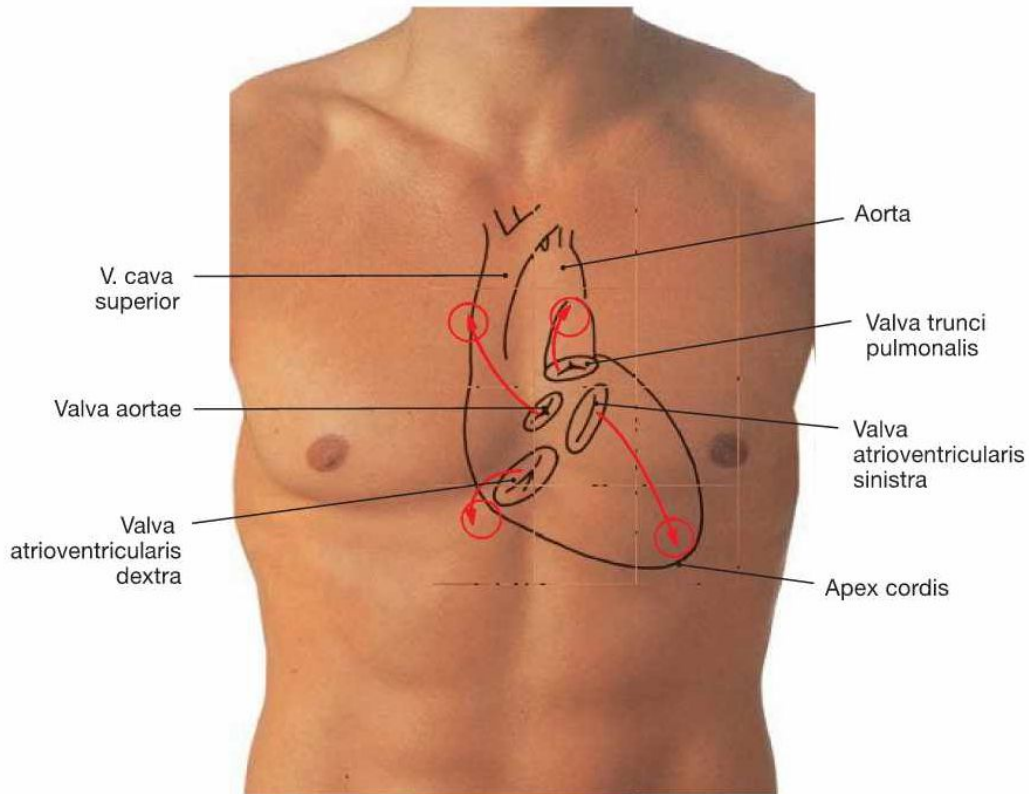


HEART NERVES

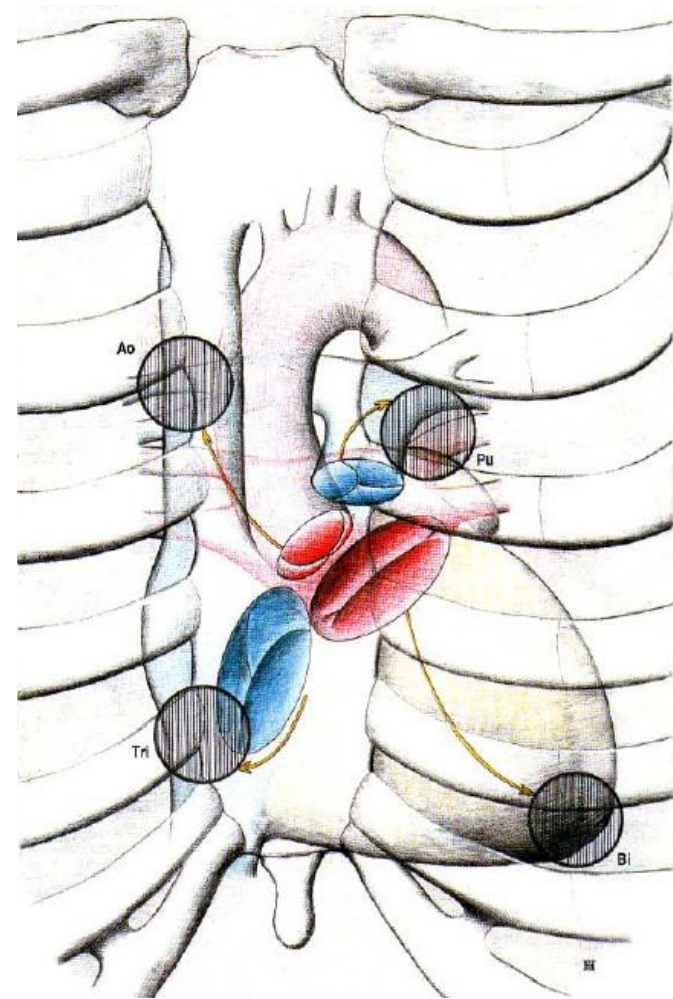
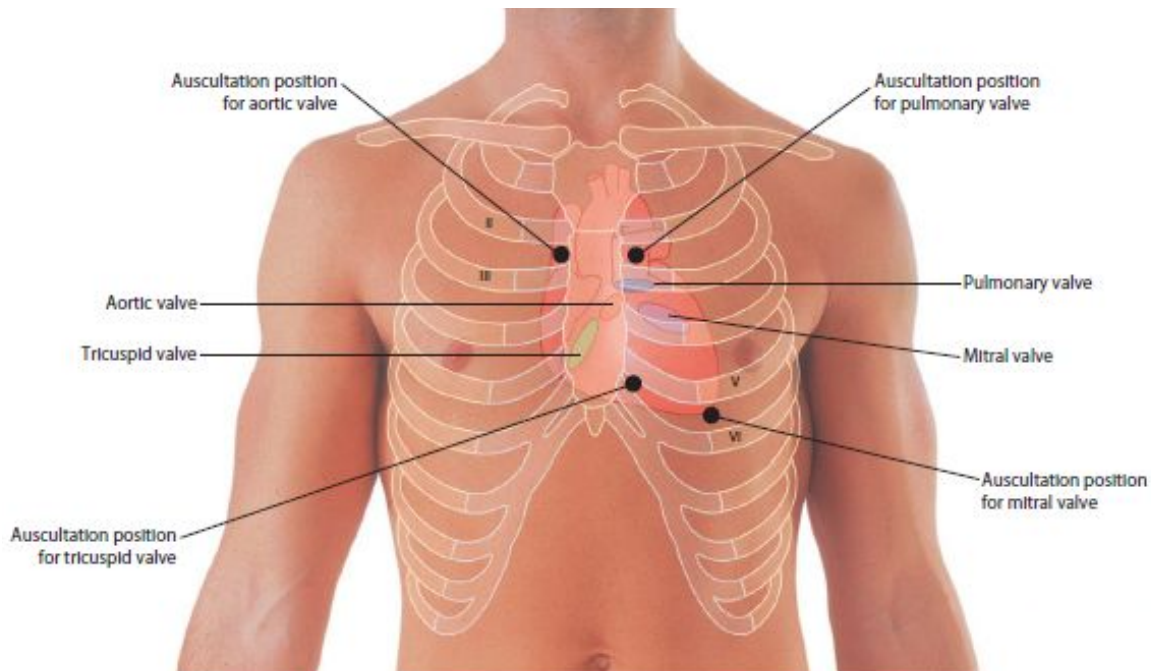
- the heart beats even when deprived of nerves
- nerves act on the tissue of the conduction system
 - they influence the frequency and intensity of heart contractions
 - sympathetic and parasympathetic fibers form the plexus cardiacus superficialis et profundus
 - sympathetic (nn. cardiaci, accelerate and intensify cardiac action and dilate coronary arteries)
 - parasympathetic (rr. cardiaci from n. vagus – ganglia near the heart – postganglionic fibers, slowing down the frequency of heart contractions and narrowing the coronary arteries)
 - sensory fibers (nociception, baroreceptors, volumoreceptors)

POSITION

- uloženo v mediastinu za sternem (1/3 vpravo, 2/3 vlevo)
- podélná osa srdeční
 - ústí v. c. s. → hrot srdeční
- bod A, B, C, D
- poloha srdce v hrudníku závislá
 - věk, poloha bránice, dýchací pohyby, tvar hrudníku, poloha těla

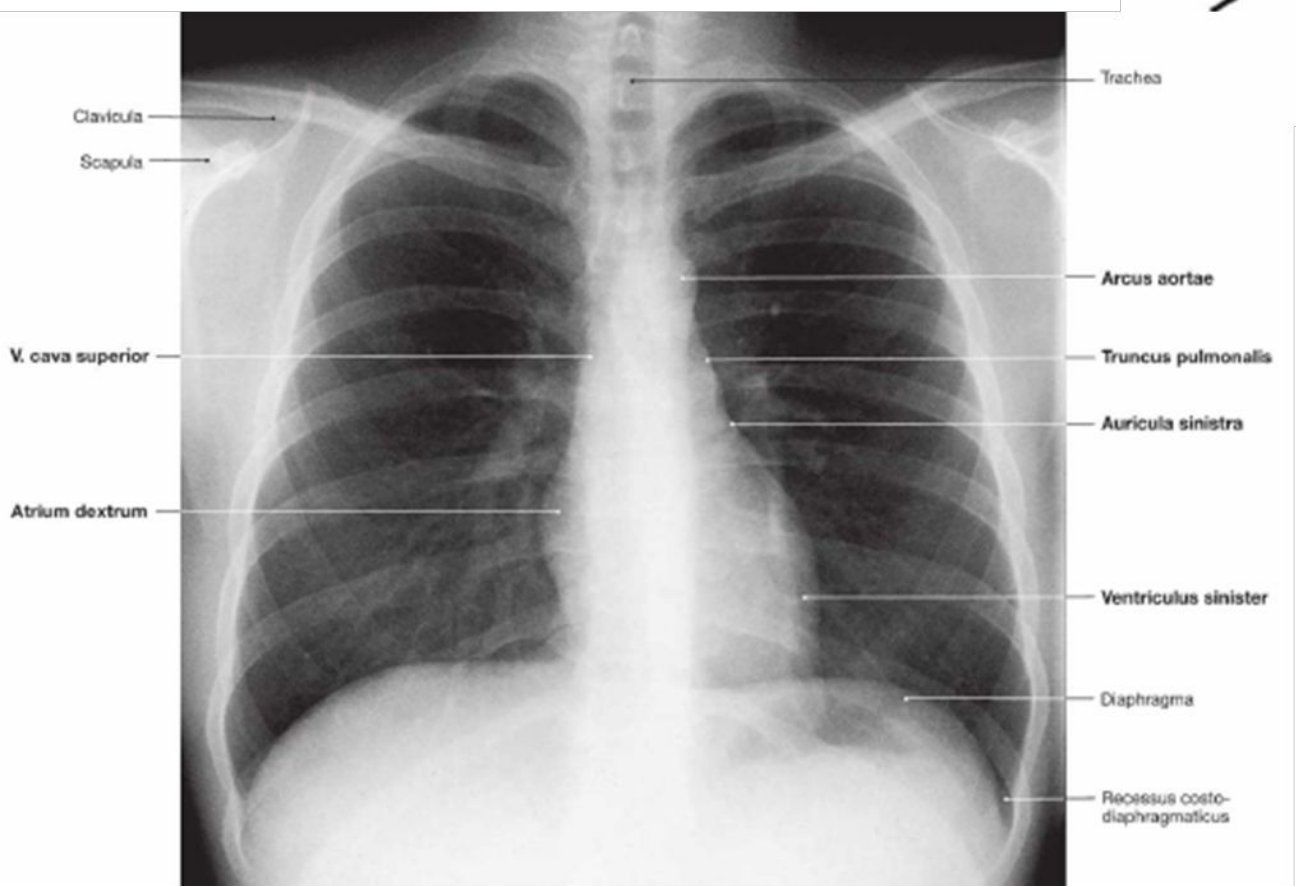
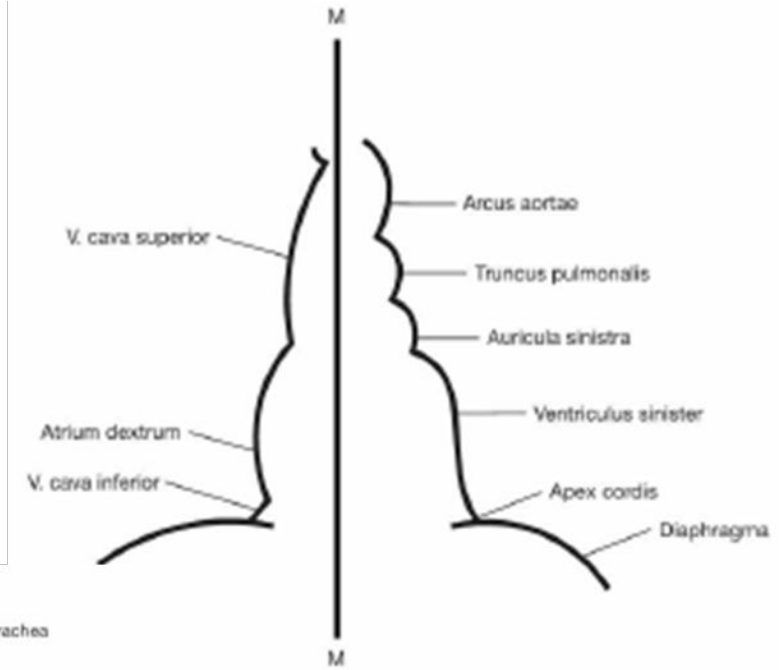


AUSCULTATION



RTG

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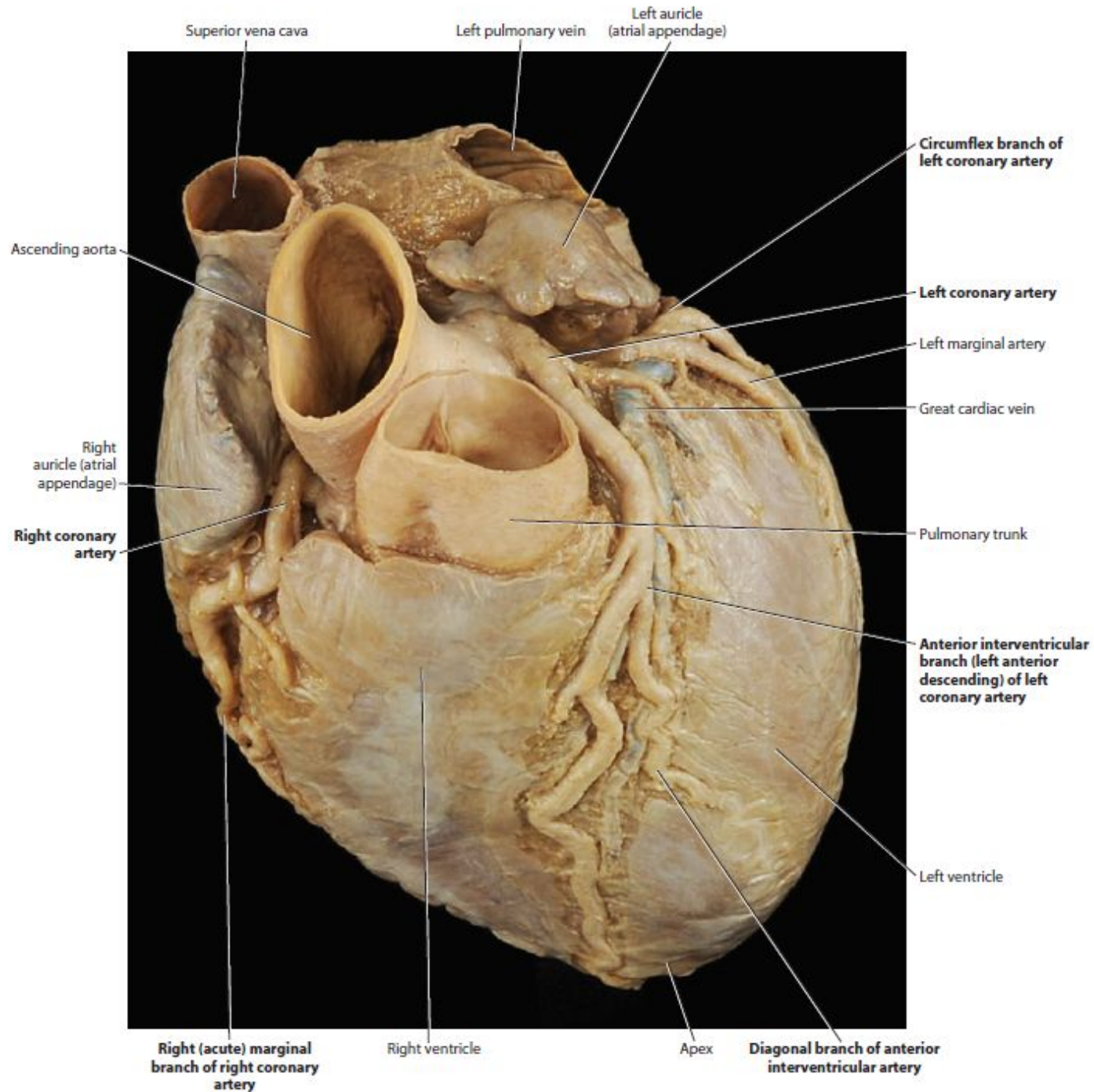


FIGURE 30.6 Heart—anterior surface. Anterior view of the sternocostal surface of the heart showing the coronary arteries.

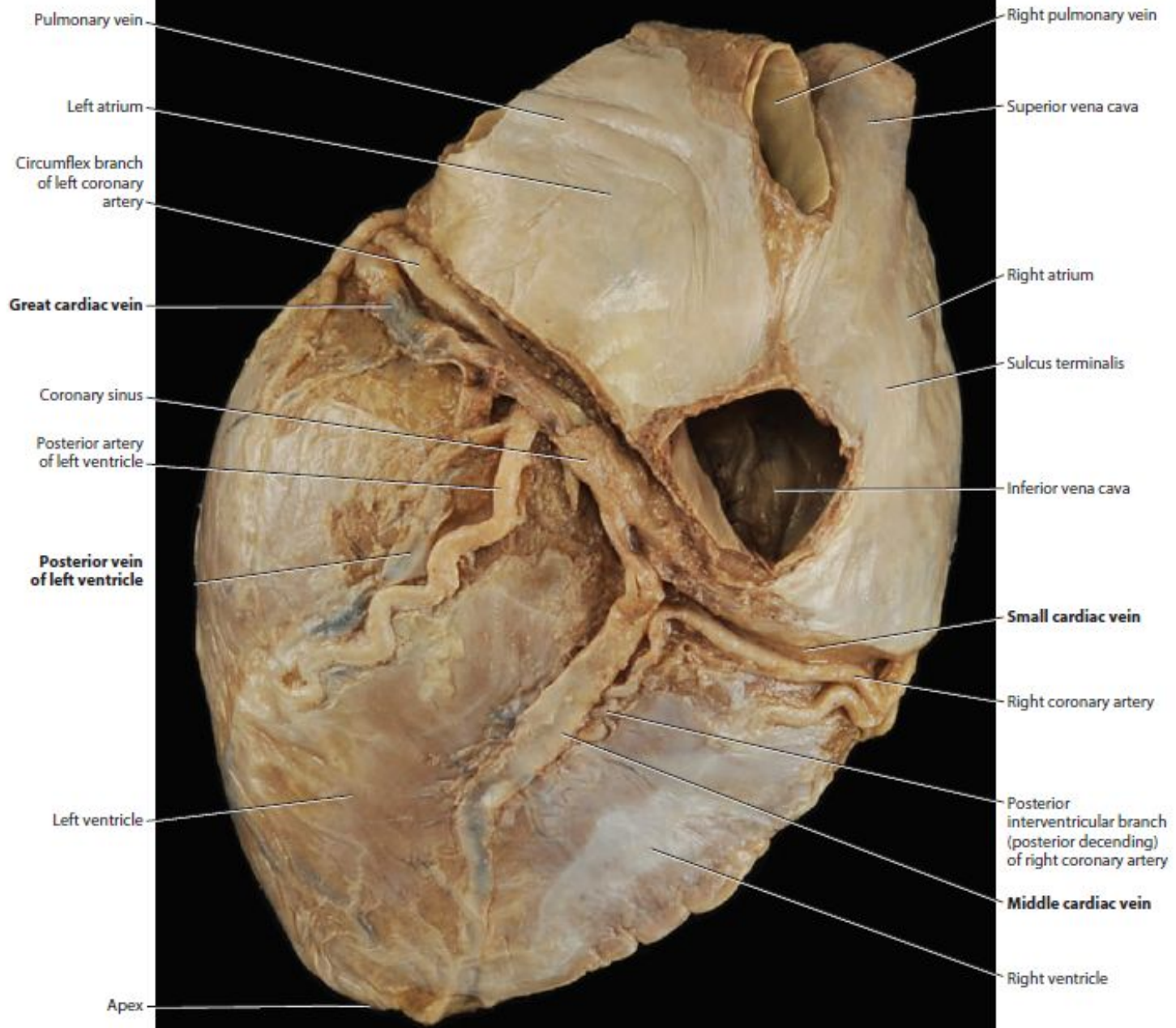


FIGURE 30.7 Heart—posterior surface. Posterior view of the diaphragmatic surface of the heart showing the venous tributaries to the coronary sinus.

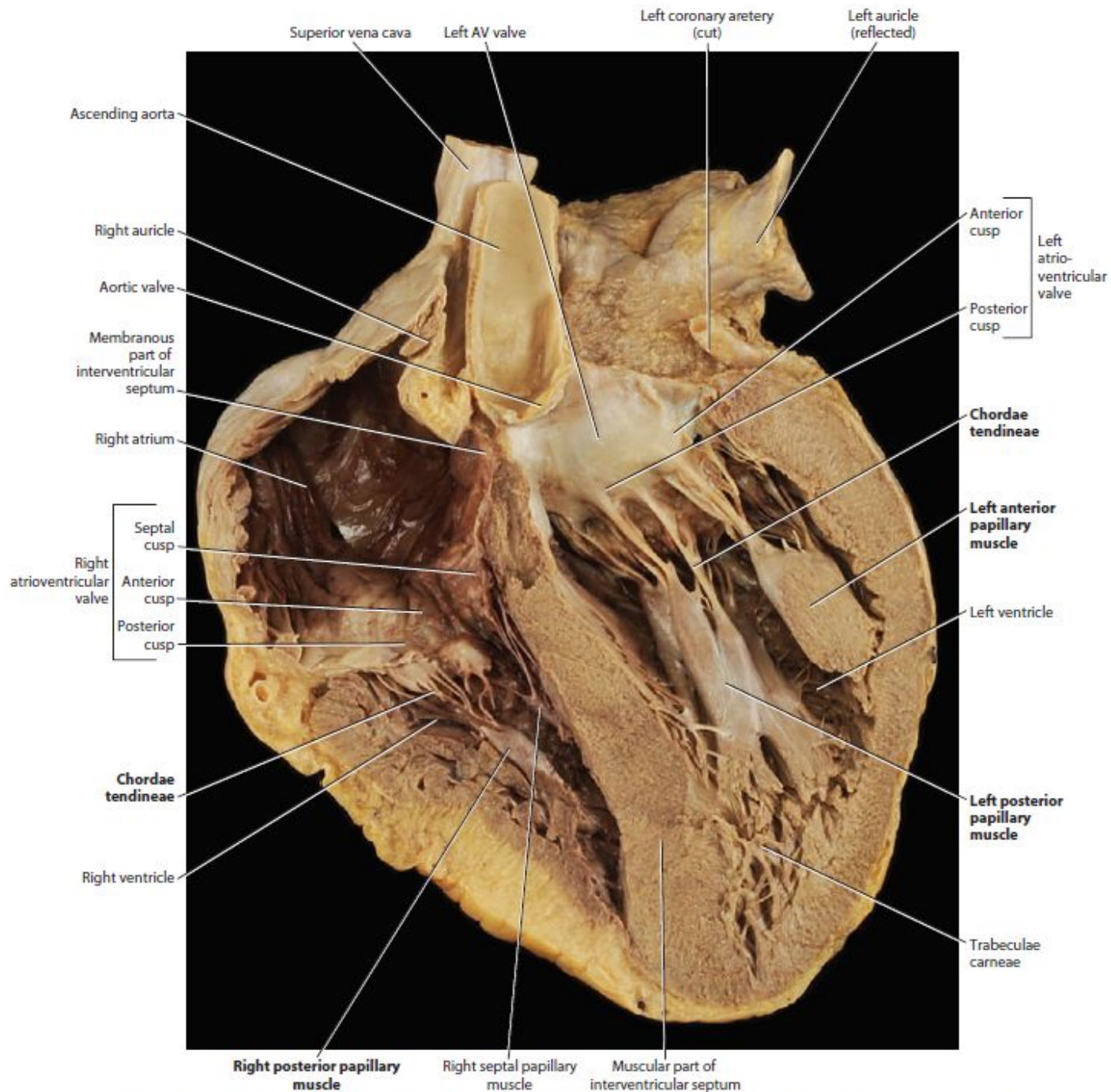


FIGURE 30.8 Heart—posterior half. Anterior view of the posterior half of the heart showing the papillary muscles with their chordae tendineae.

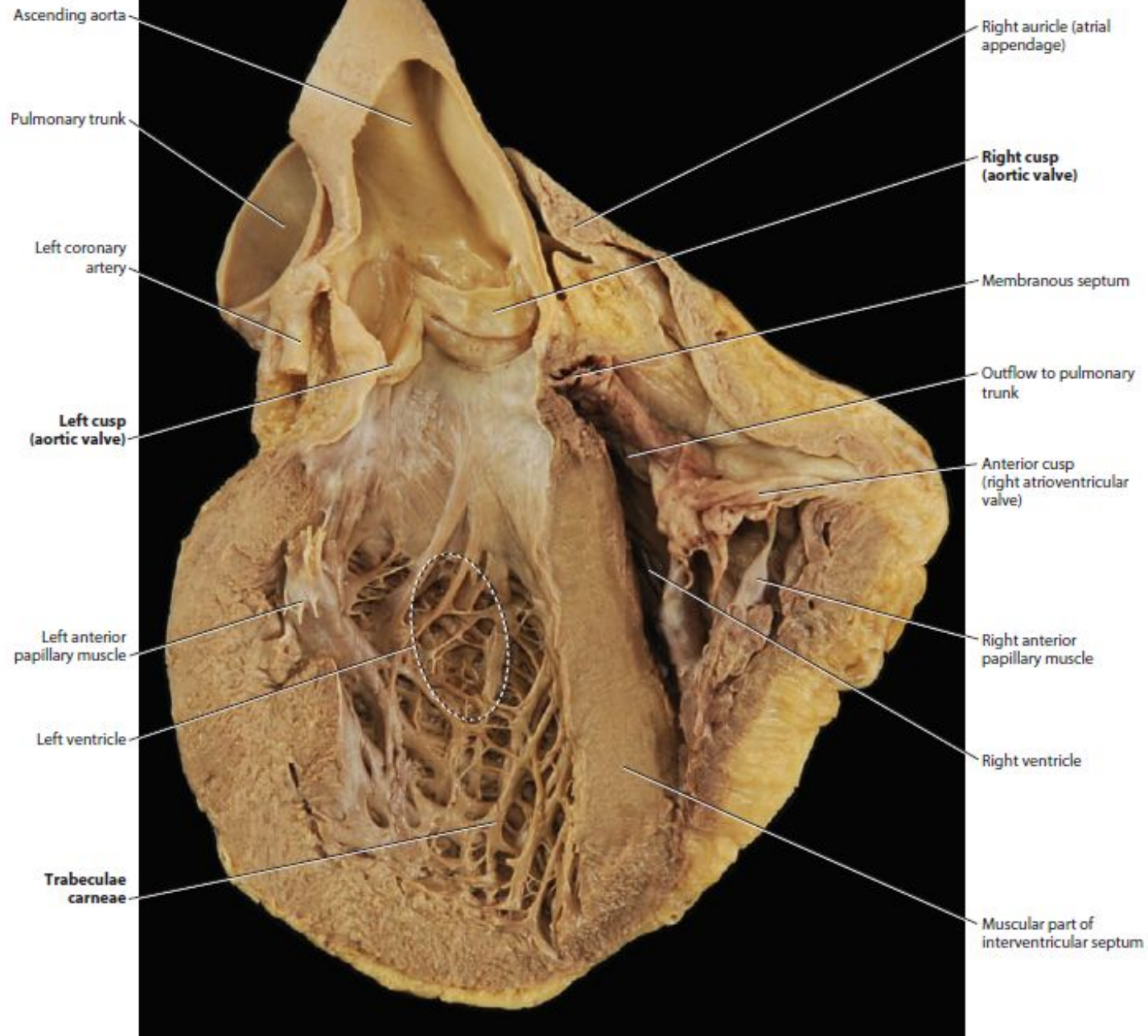


FIGURE 30.9 Heart—anterior half. Posterior view of the anterior half of the heart showing the two aortic valve cusps and the trabeculae carneae within the walls of the left ventricle.

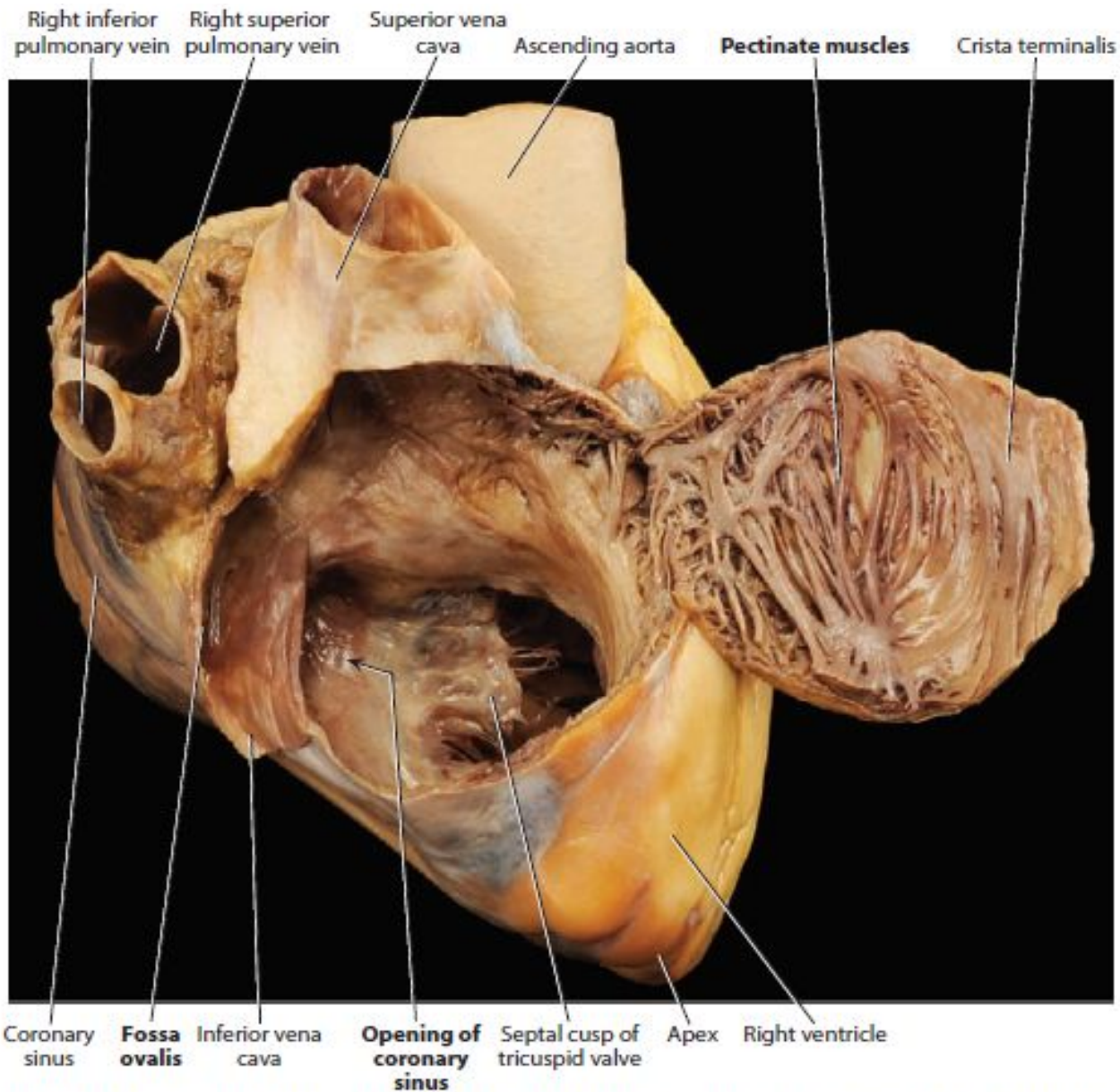


FIGURE 30.10 Heart—right atrium. Opened right atrium from a right lateral view showing the internal features.

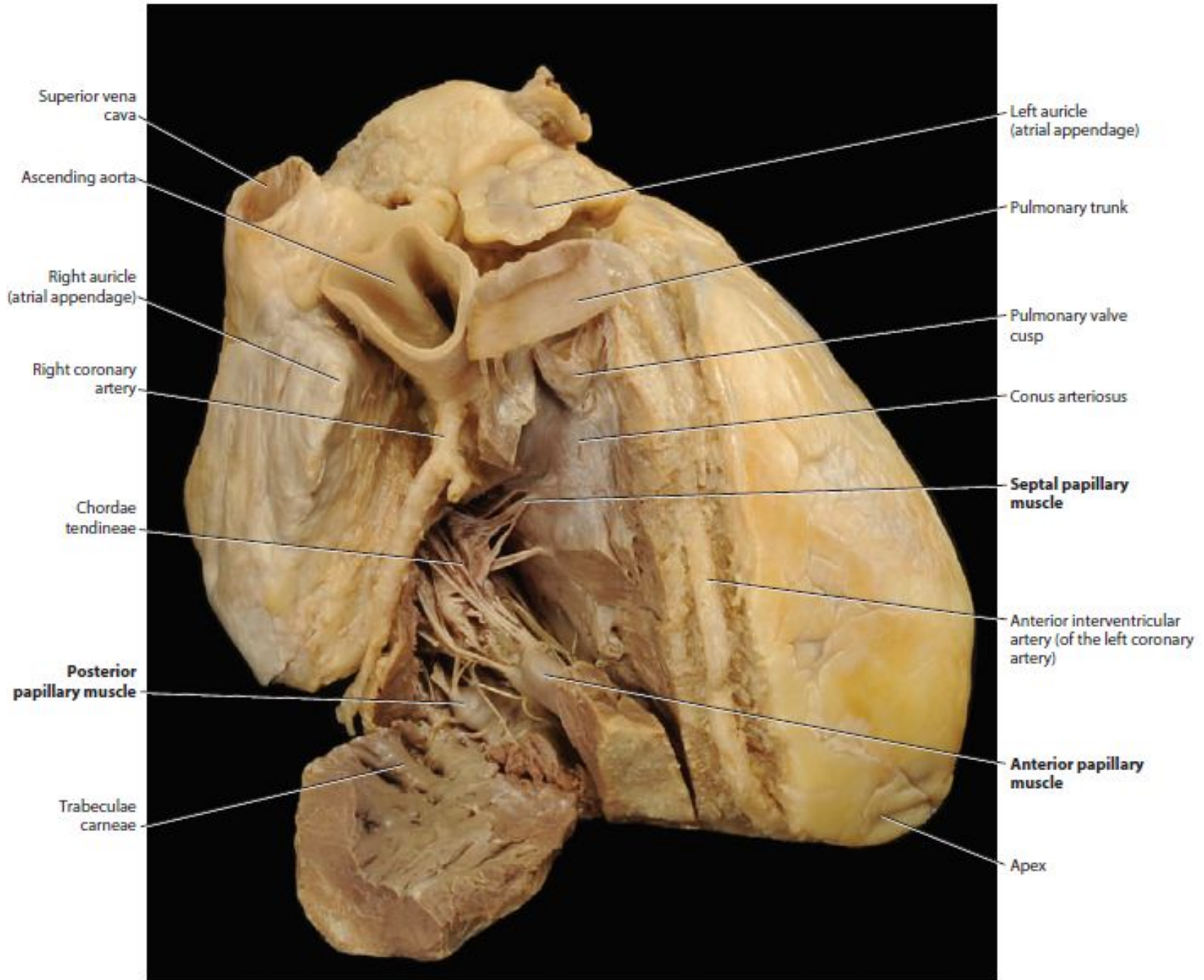


FIGURE 30.11 Heart—right ventricle. Opened right ventricle from an anterior view showing the three papillary muscles.

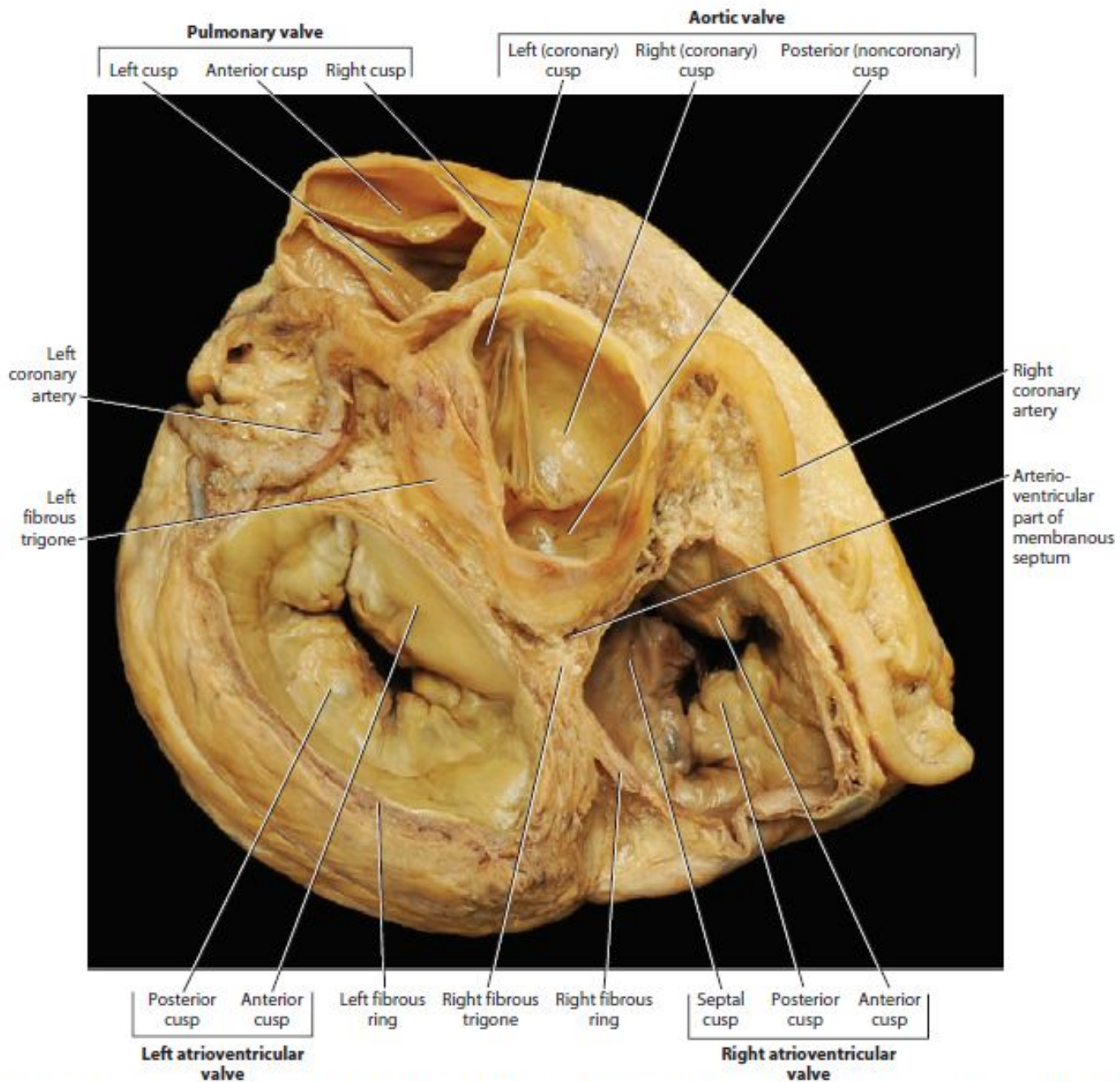


FIGURE 30.12 Heart—valves. Superior view of the heart with the atria removed showing the 11 cusps of the four sets of valves and the fibrous skeleton.