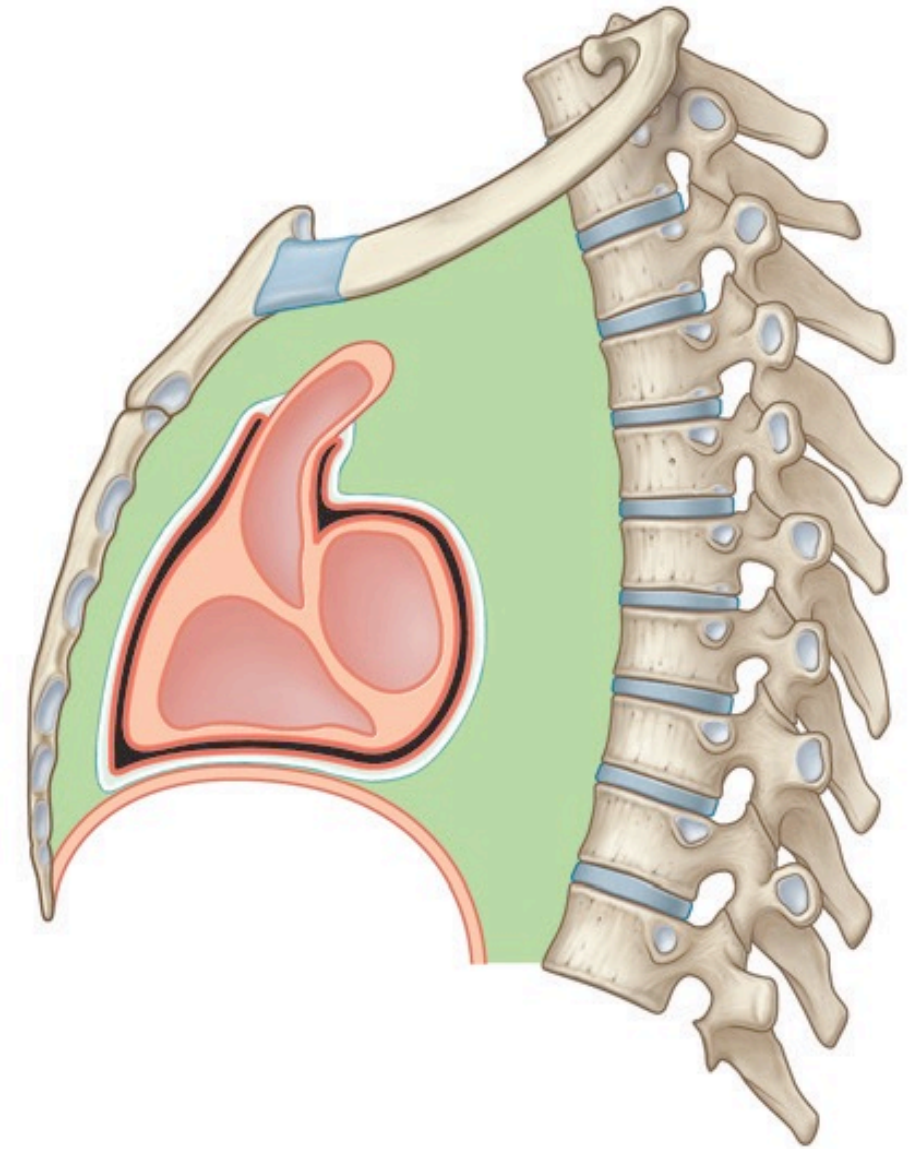
THORAX - HEART

Prof. MUDr. Jiří Ferda, Ph.D.



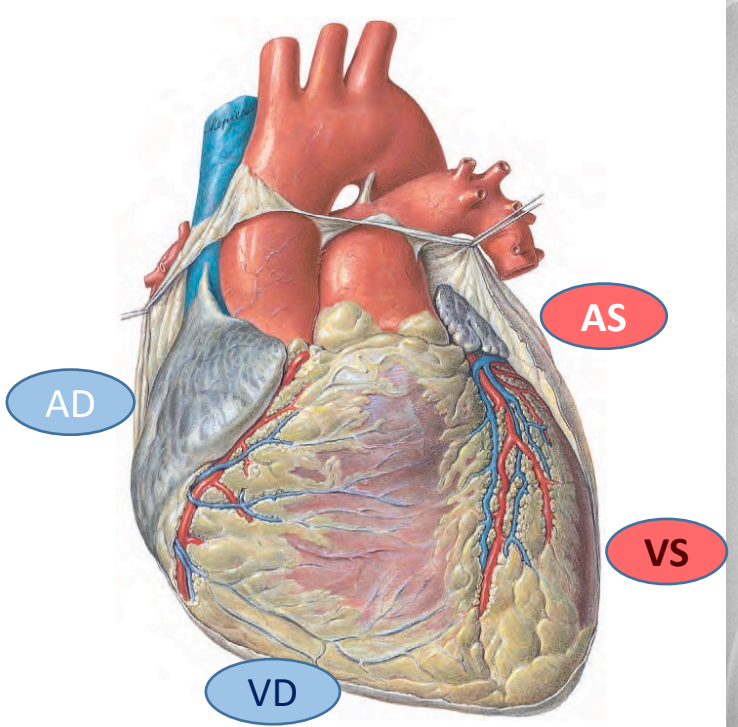
- Middle mediastinum
  - Paired pump in seriál arrangement
- Cor dextrum - venous
- Cor sinistrum - arterial

- Small circulation- circulus sanguinis minor
  - Right ventricle - left atrium
- Large circulation - circulus sanguinis major
  - Left ventricle - right atrium

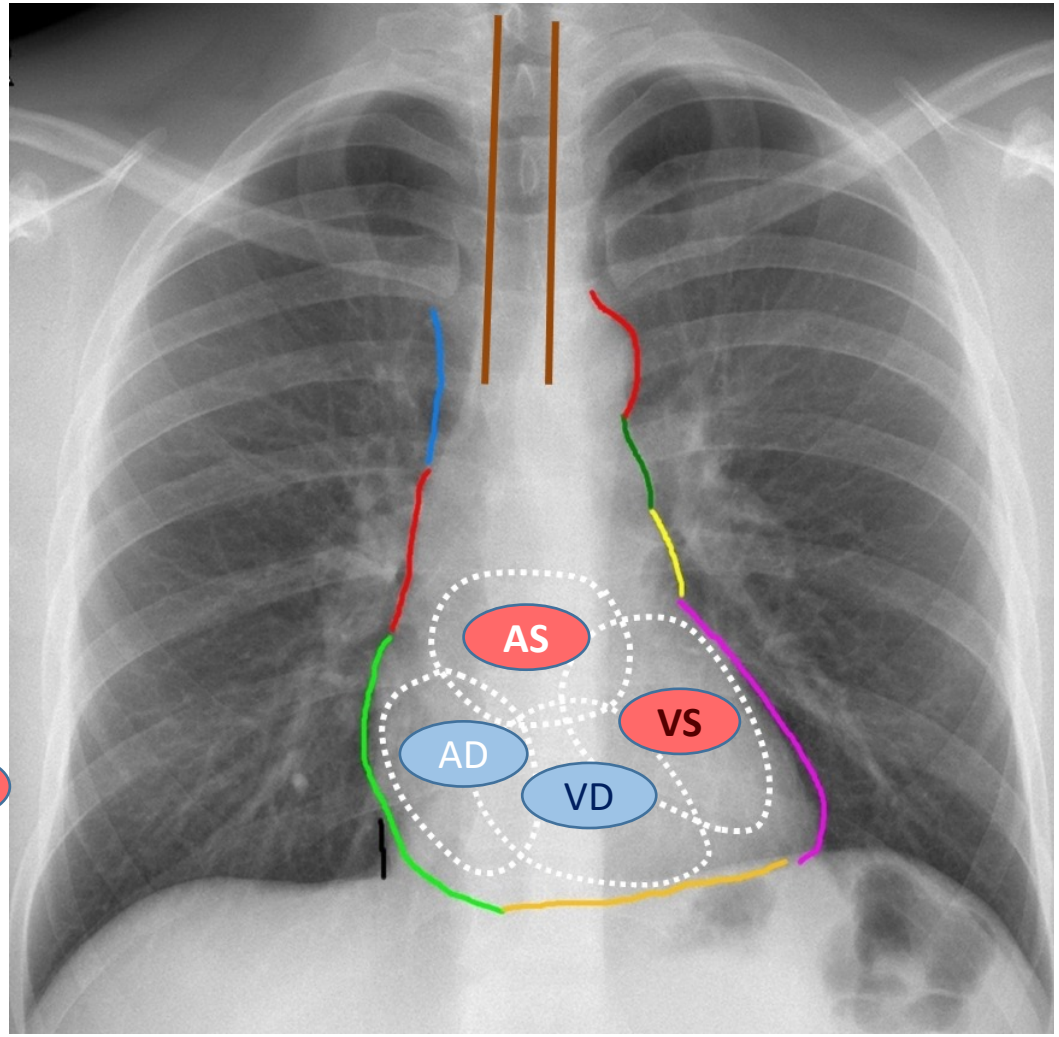
HEART - COR

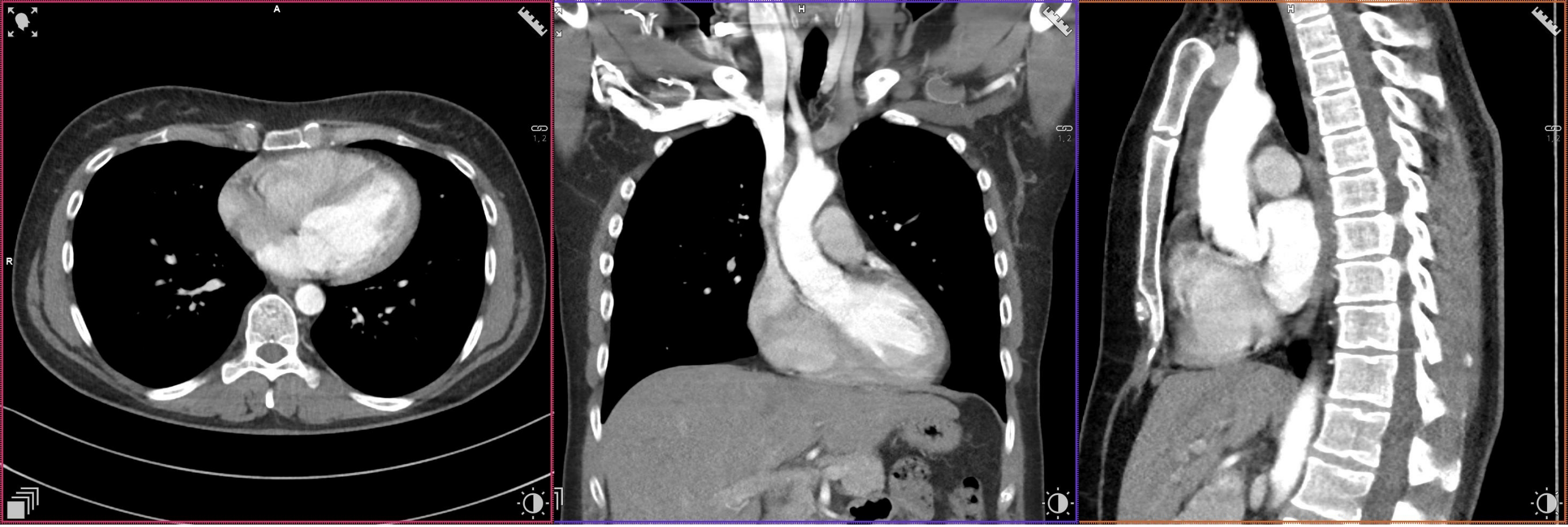
HEART - COR

- hollow muscular organ localized in mediastinum
- PAIRED MUSCULAR PUMP
- Endocardium
  - valves
- Myocardium
  - Working myocardium
  - Conduction system
- Epicardium
  - Epicardial fatty tissue
  - Cardiac vessels
- Pericardium
  - Pericardial sac
- Blood vessels, lymphatic vessels and nerves



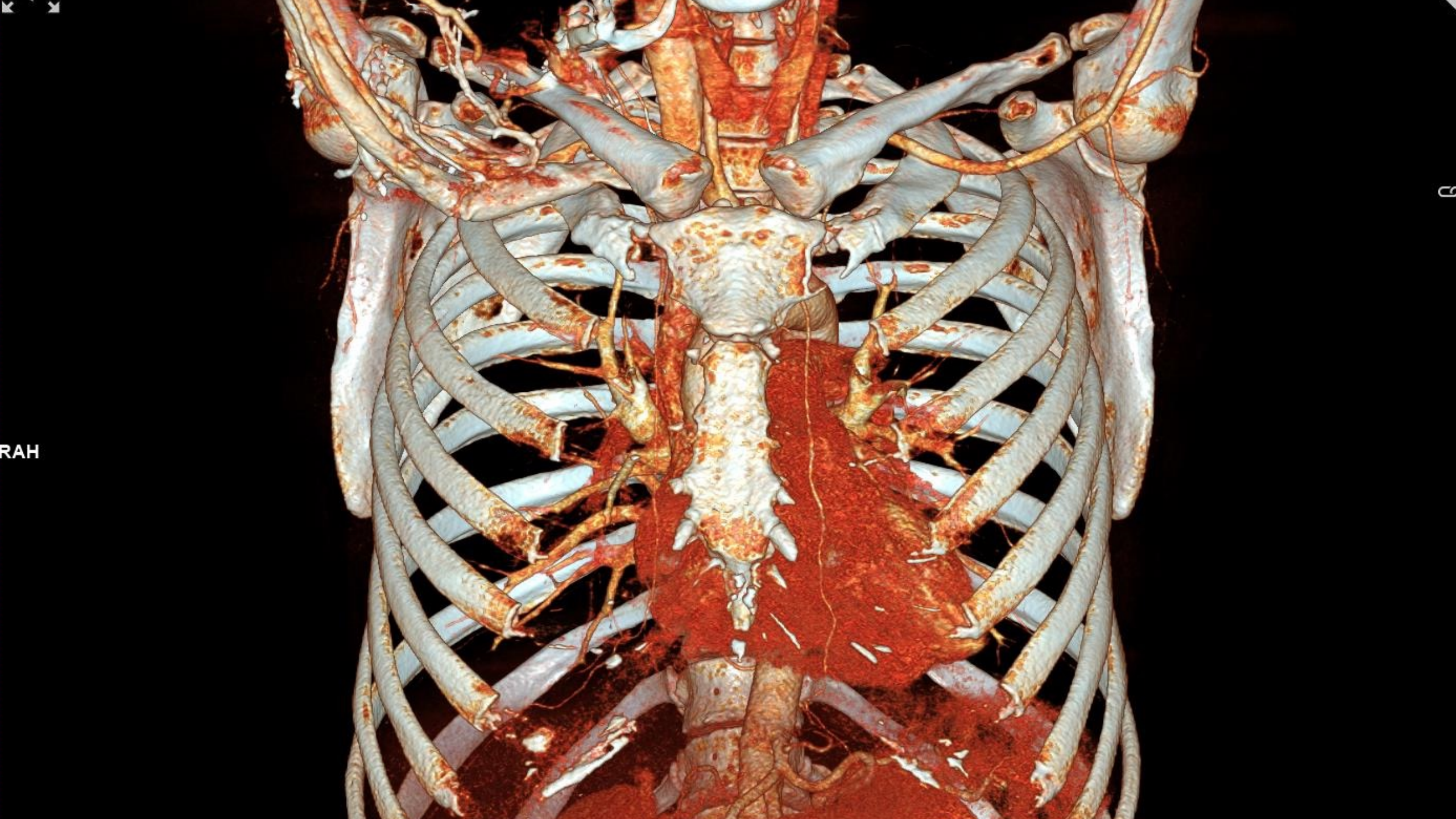
© Grey´s Anatomy 41th ed.

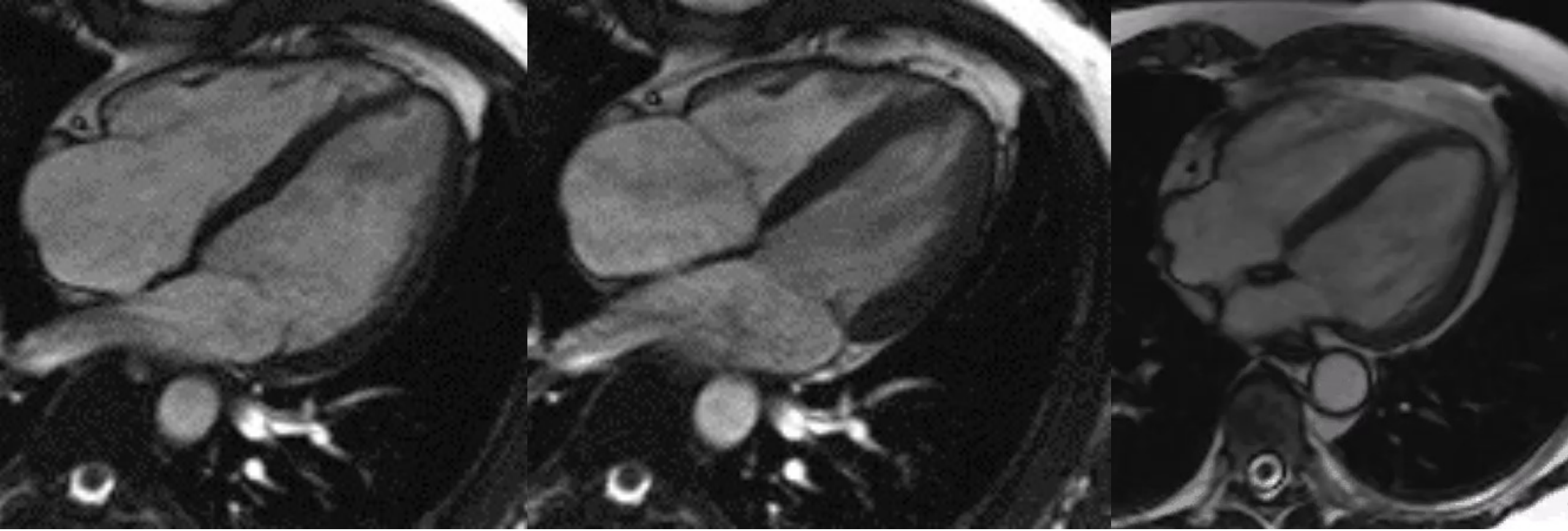


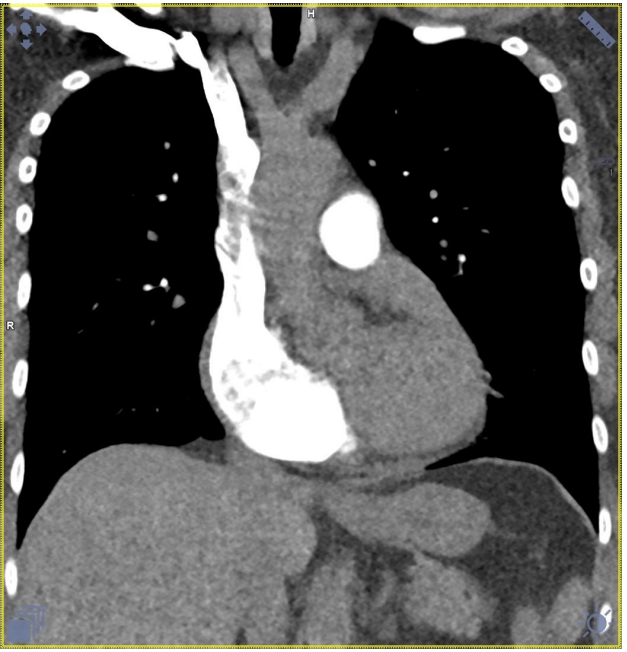


- Retrosternal RV
- Heart axis
- Angle of 45 gr.

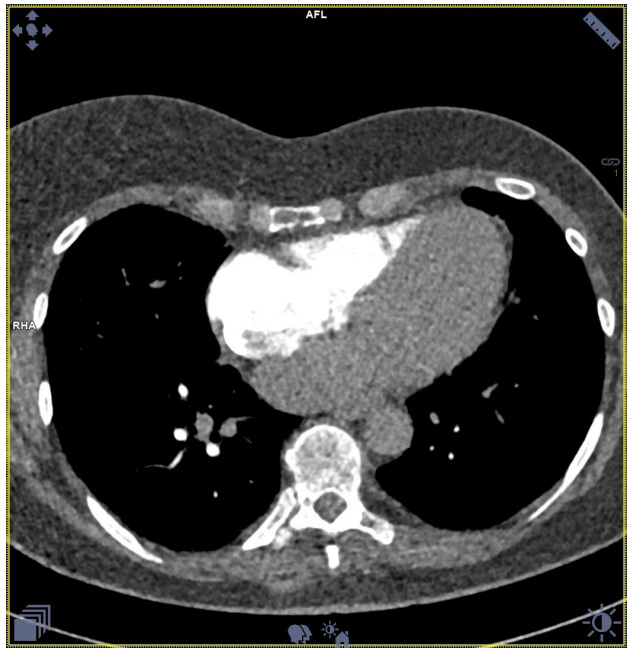
HEART POSITION






H
R

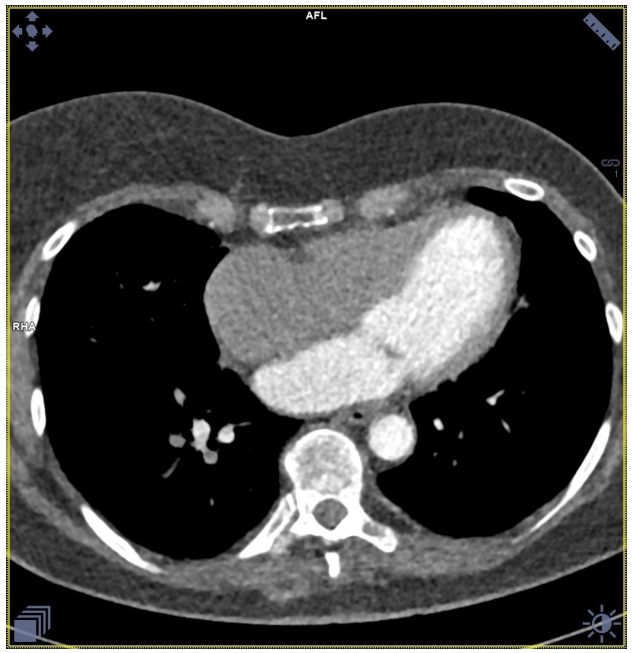

H
R


AFL
RHA


HLA
ARH

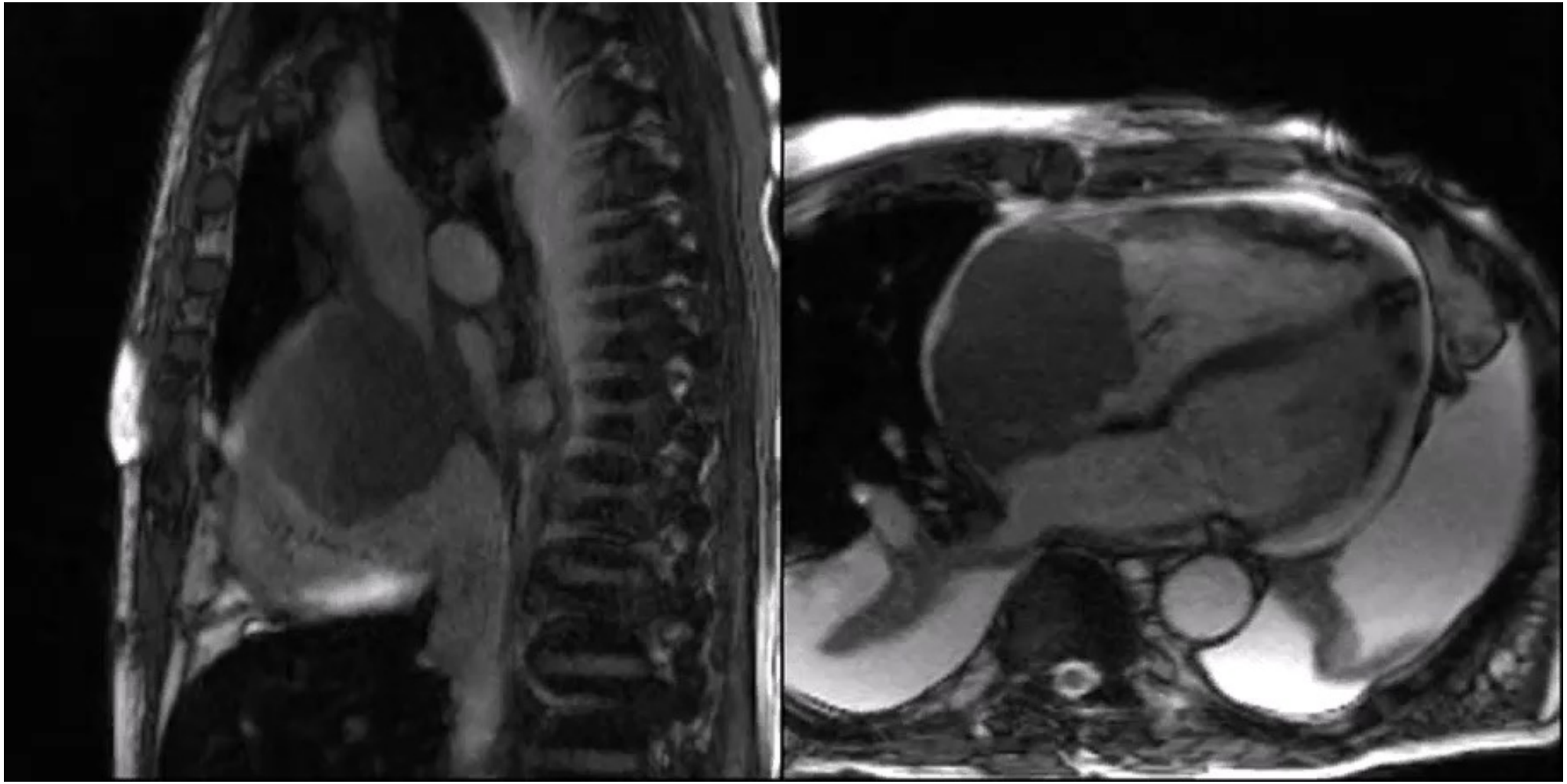

H
R


H
R


AFL
RHA


HLA
ARH

IMPAIRED BLOOD FLOW



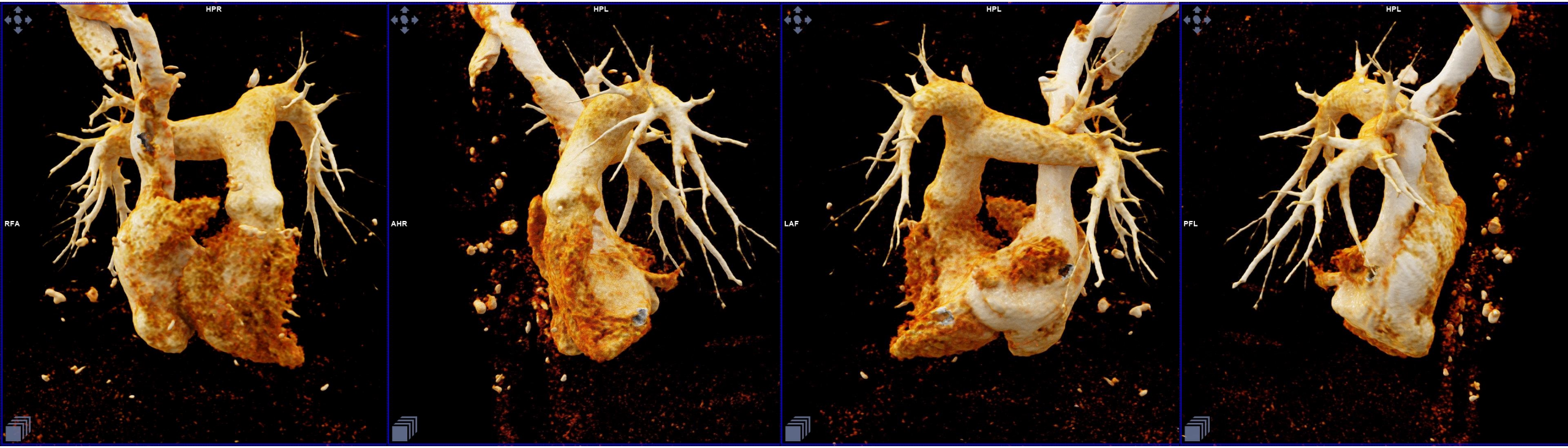
AORTA AND PULMONARY TRUNK

- Aorta
  - 120/80 mmHg
  - aorta thoracica
    - *aorta ascendens*
    - *arcus aortae*
    - *isthmus aortae*
    - *aorta descendens*
  - aorta abdominalis
  - aorta caudalis
    - *a. sacralis mediana*
- truncus pulmonalis
  - 8-20 mmHg
  - a. pulmonalis dextra
  - a. pulmonalis sinistra

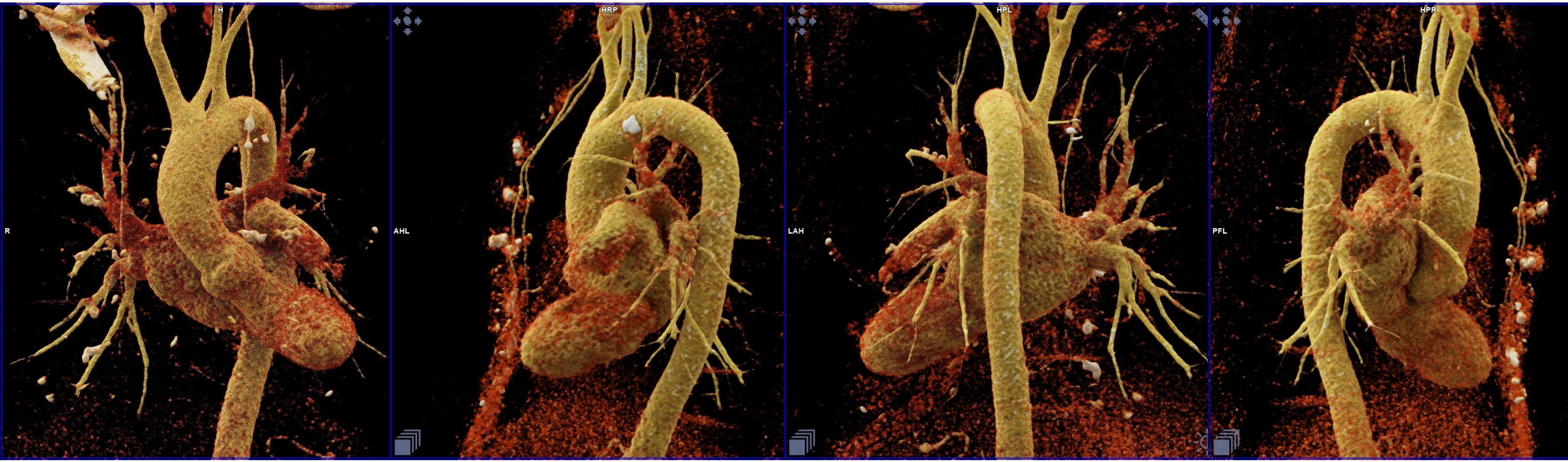

HPL
4

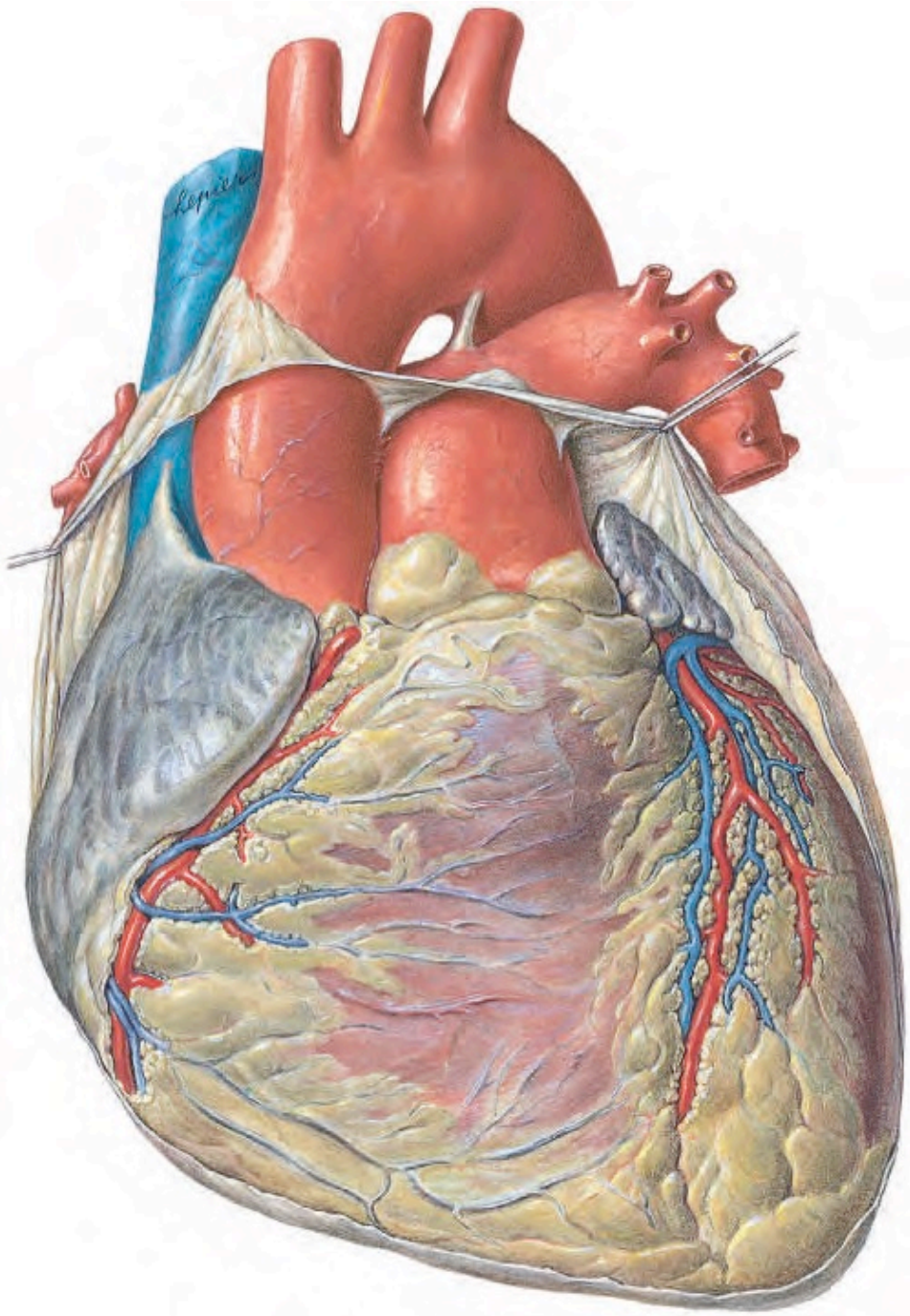

H
R

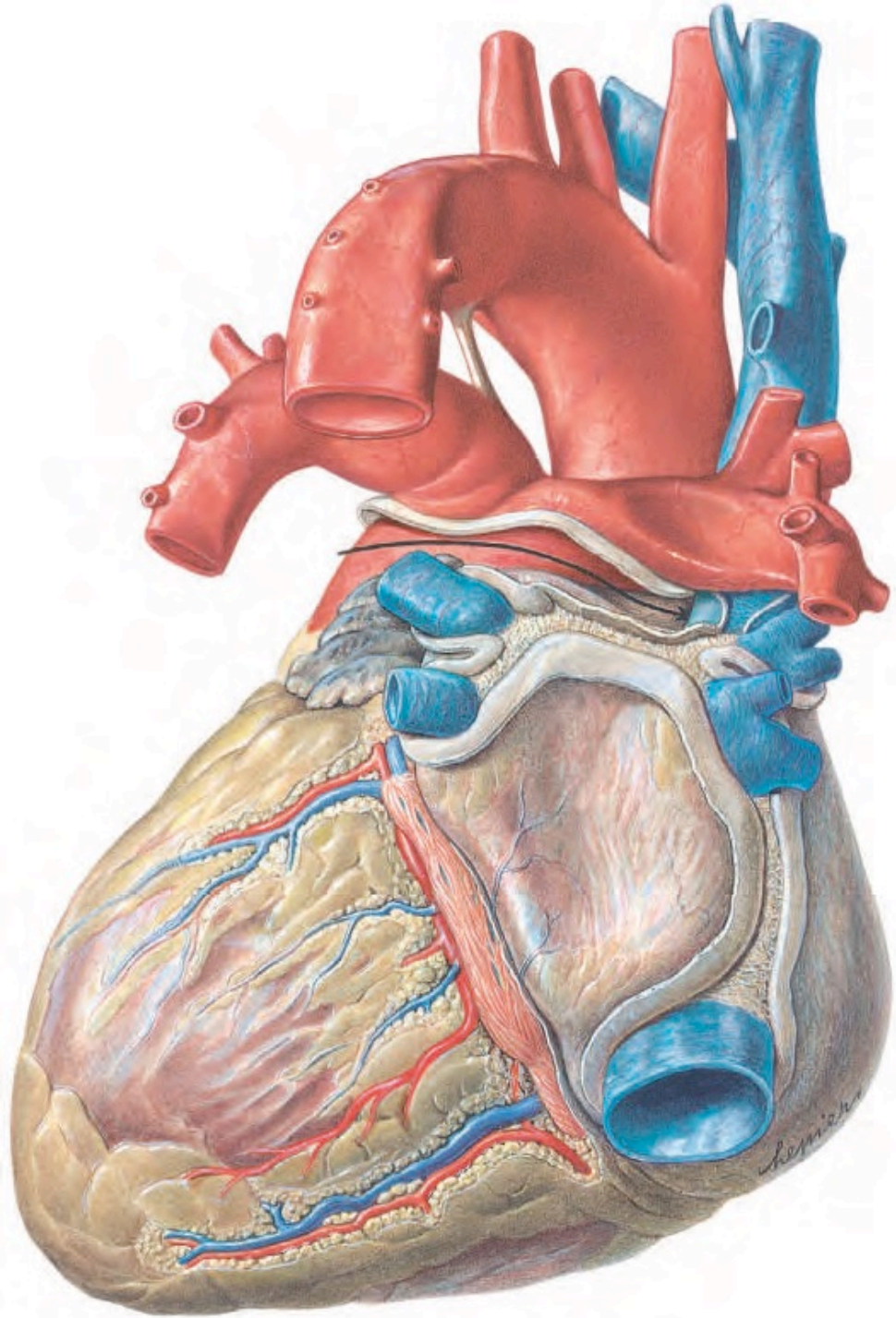
PULMONARY ARTERY

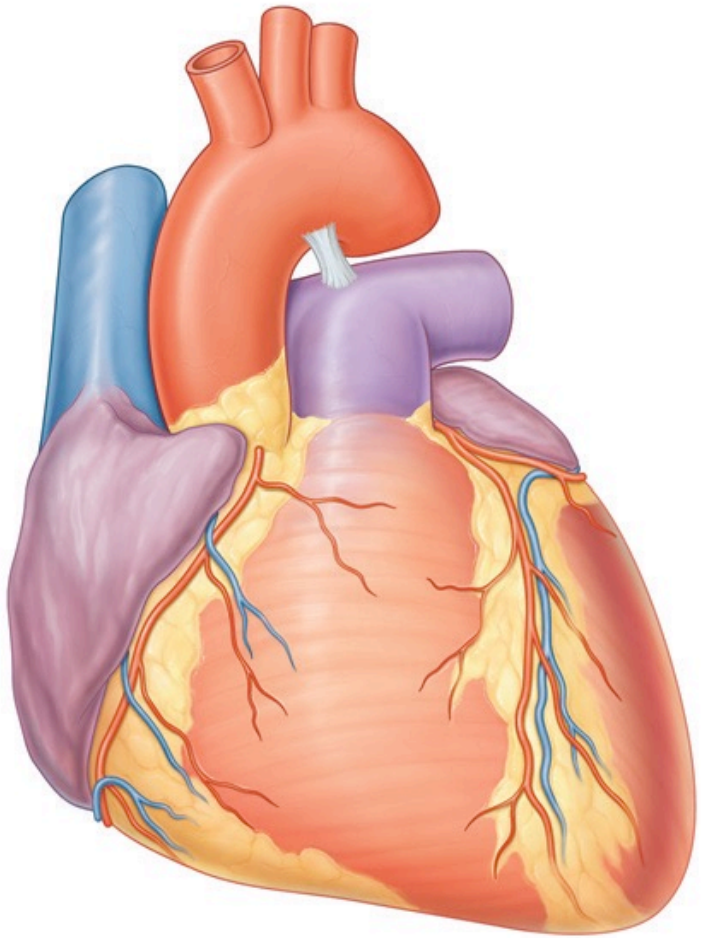


AORTA



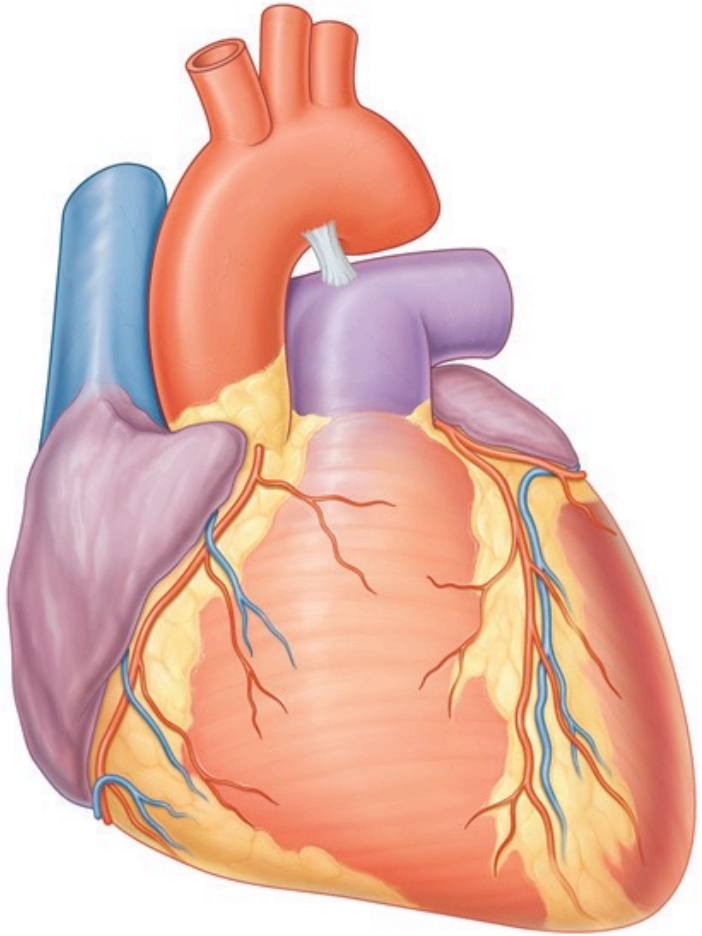


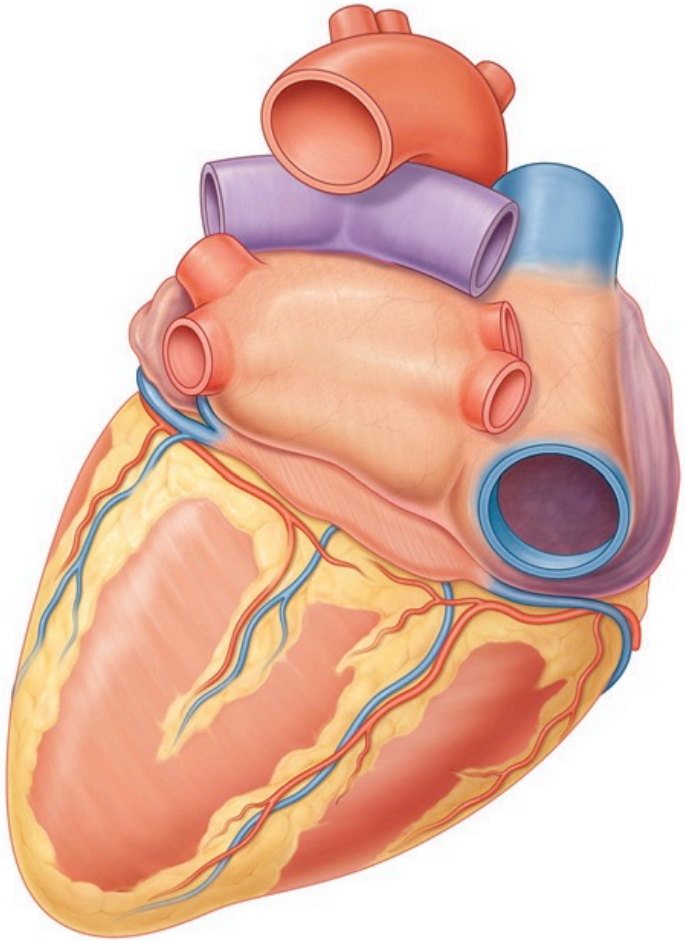




- Apex - basis 12 cm
- Maximum width 9 cm
- Antero-posterior 6 cm
- weight
- M 280 -340 g , average 300 g
- F 230 - 280 g, average 250 g

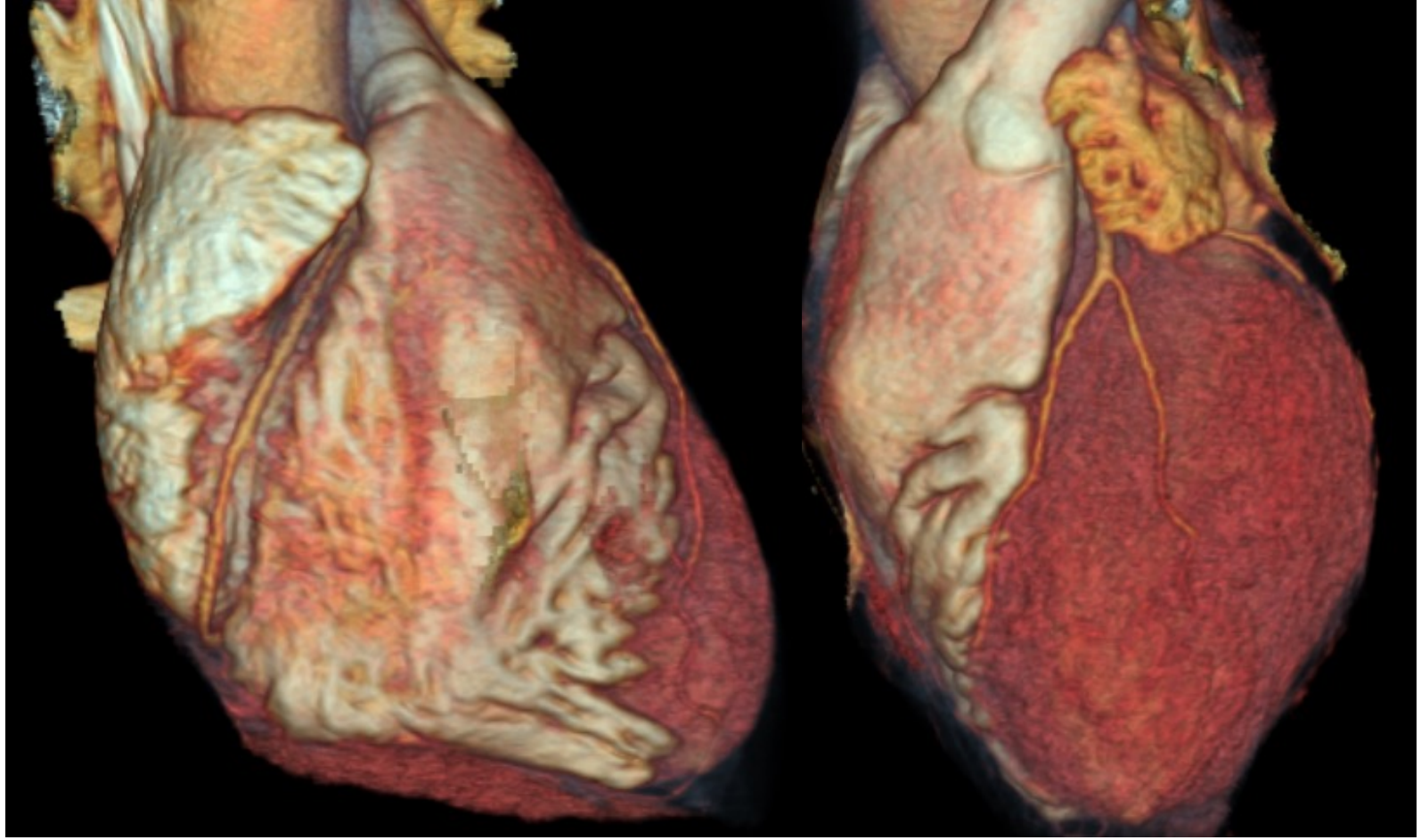
SIZE AND WEIGHT OF THE HEART





- Ventriculus dexter
- Ventriculus sinister
- Atrium dextrum
- Atrium sinistrum
- Basis cordis
- Apex cordis
- Margo superior
- Margo inferior - acutus
- Margo dexter
- Margo sinister - obtusus
- Sulcus atrioventricularis (coronarius)
- Sulcus interventricularis anterior
- Sulcus interventricularis posterior
- Sulcus interatrialis
- Ostia arteriarum
- Ostia venarum

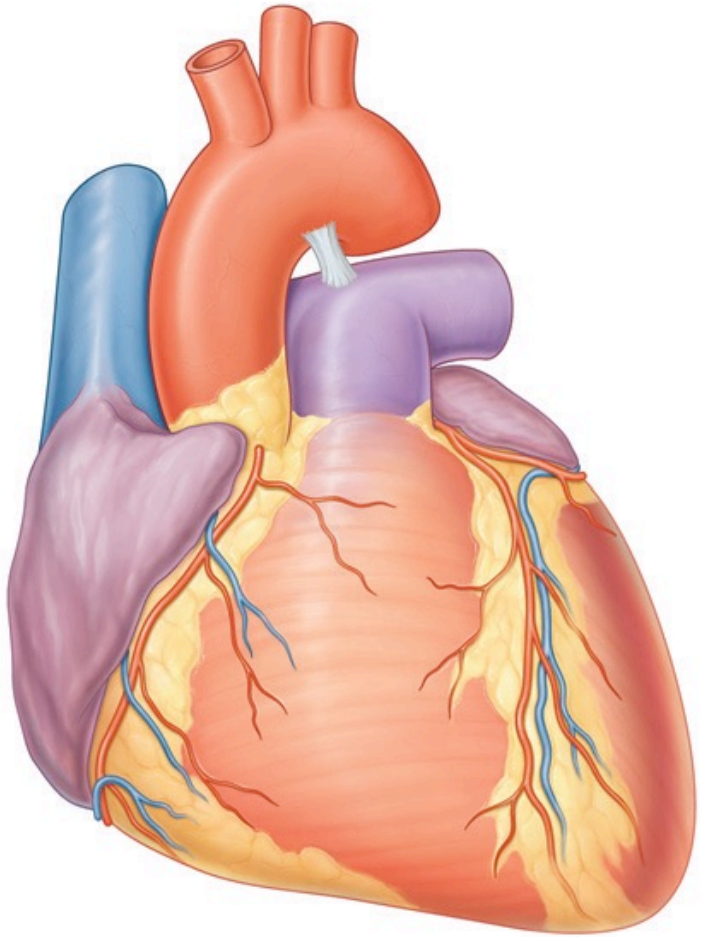
HEART DESCRIPTION



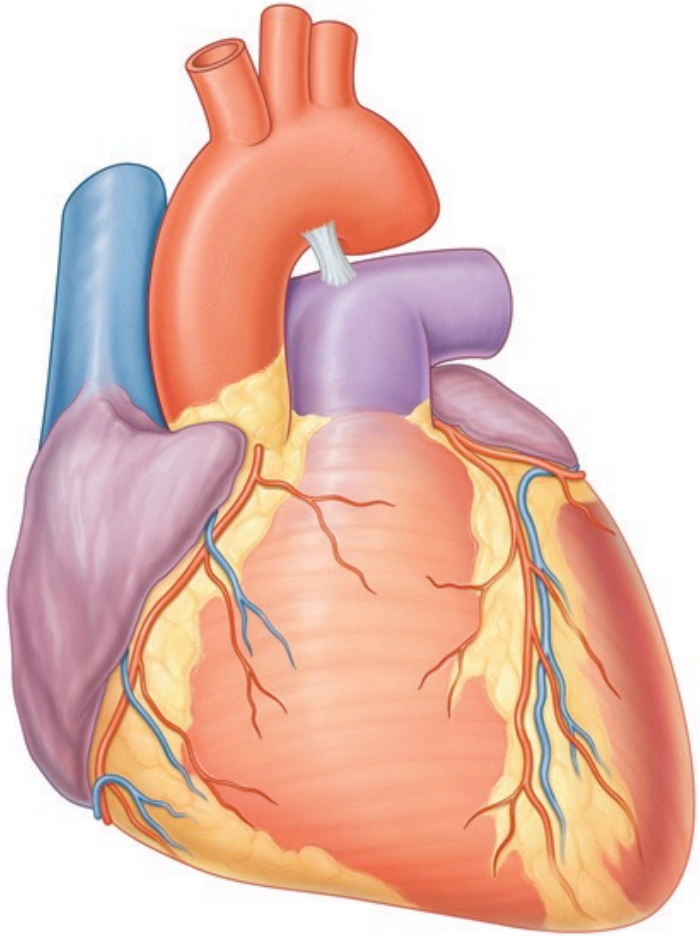
- Ventriculus dexter
- Conus arteriosus - infundibulum
- Ventriculus sinister
- Atrium dextrum
- Auricula dextra
- Atrium sinistrum
- Auricula sinistra
- Apex cordis
- Margo inferior - acutus
- Margo dexter
- Margo sinister - obtusus
- Sulcus atrioventricularis (coronarius)
- Sulcus interventricularis anterior

HEART DESCRIPTION

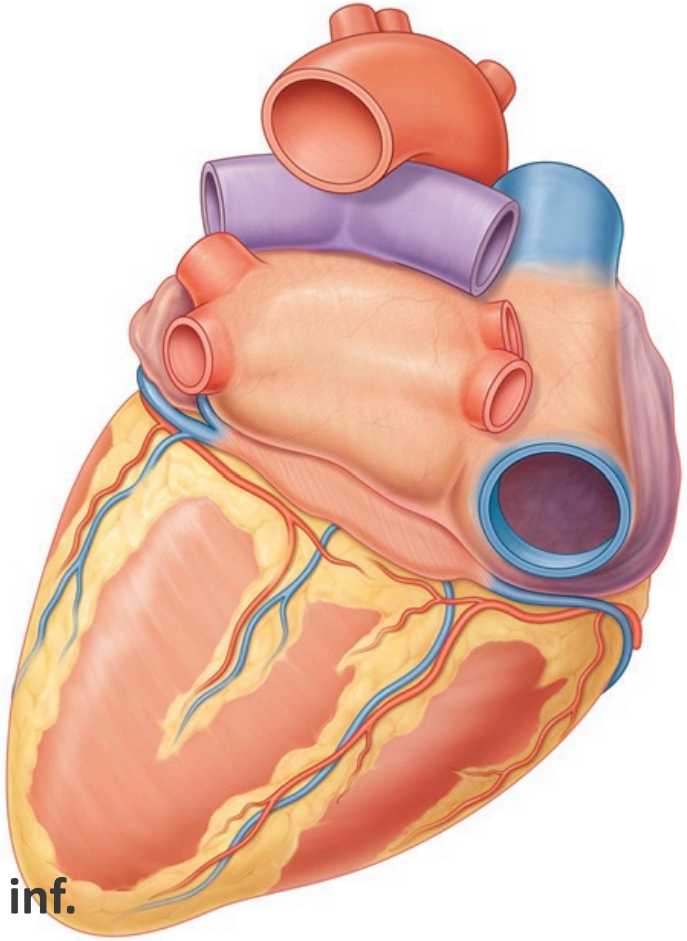
- Margo superior
  - Atrium sinistrum
- Margo dexter
  - Atrium dextrum
- Margo inferior (acutus)
  - Ventriculus dexter
- Margo sinister (obtusus)
  - Vericulus sinister



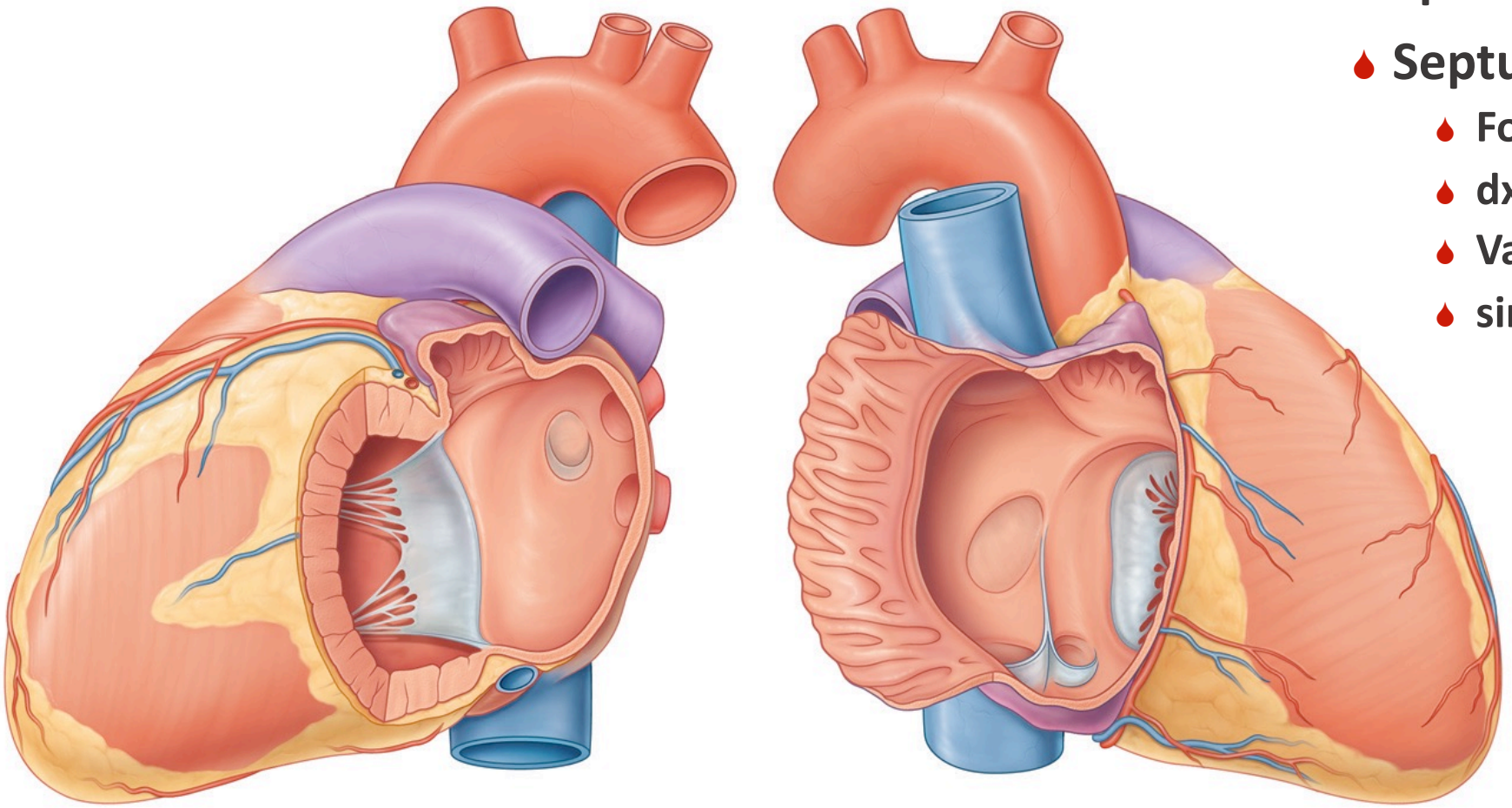
MARGINES CORDIS



- Sulcus interatrialis
- Sulcus interventricularis
  - interior et inferior
- Sulcus atrioventricularis - coronarius
  - Plane in 45 gr. angle with sagittal plane
- Crux cordis - transcision
  - Atrioventricularis, interventr. inf.

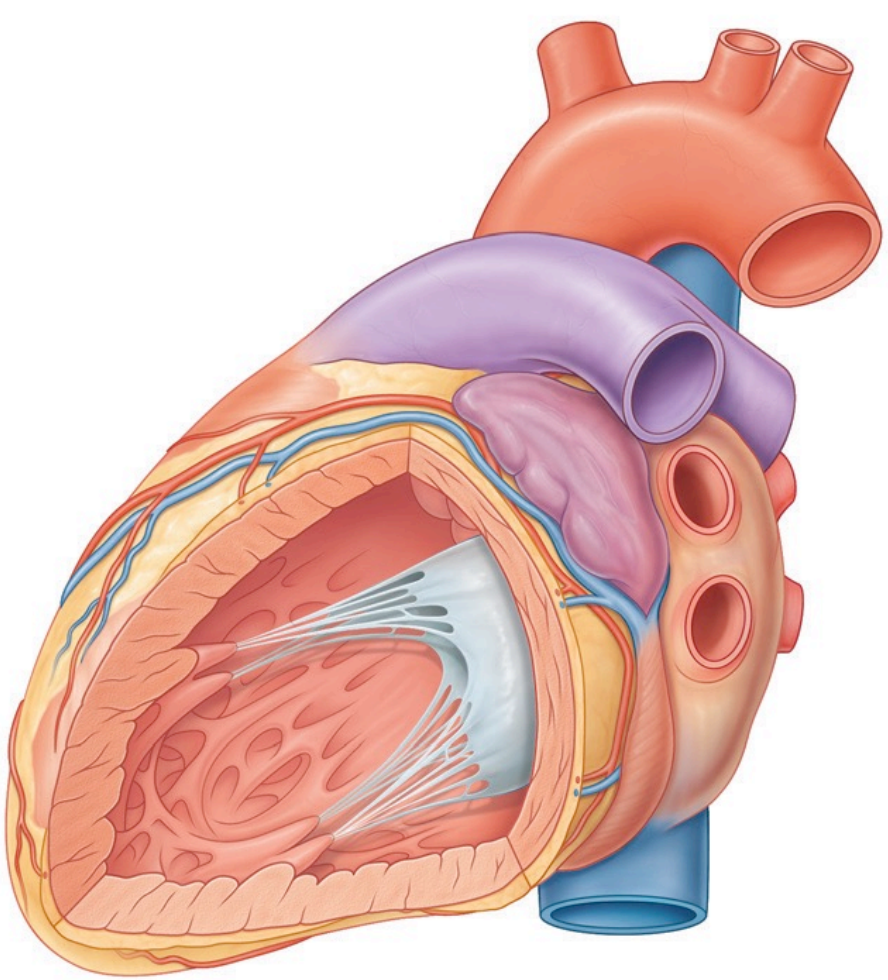


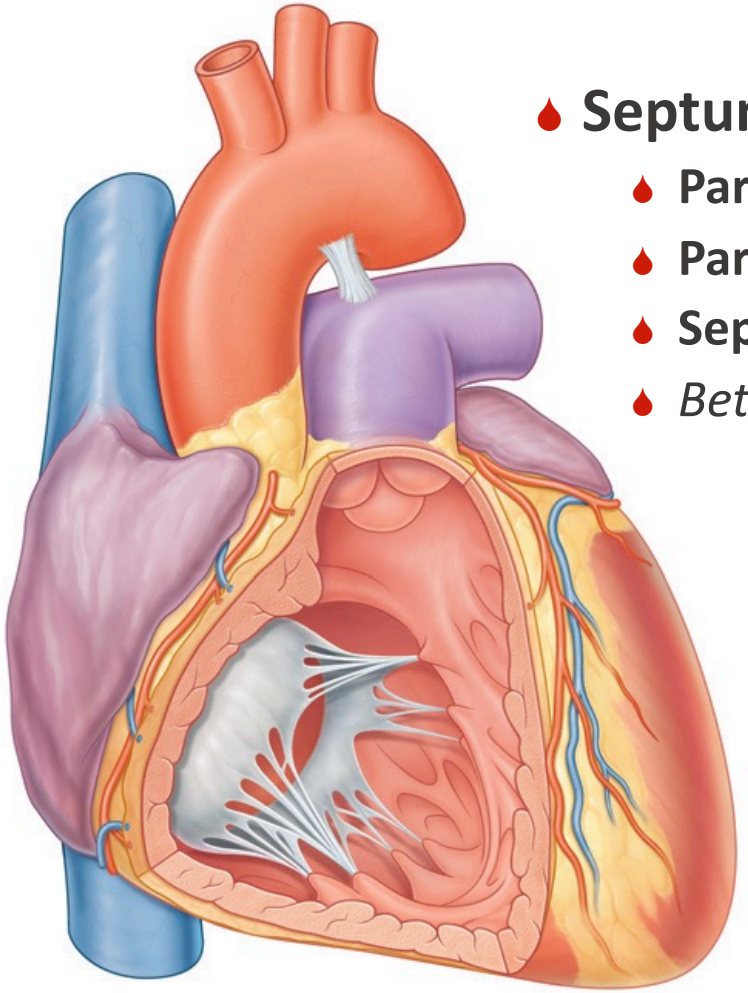
SULCI CORDIS



- Split of cardiac cavities
- Septum interatriale
  - Fossa ovalis
  - dx
  - Valva foraminis ovalis
  - sin

SEPTA CORDIS



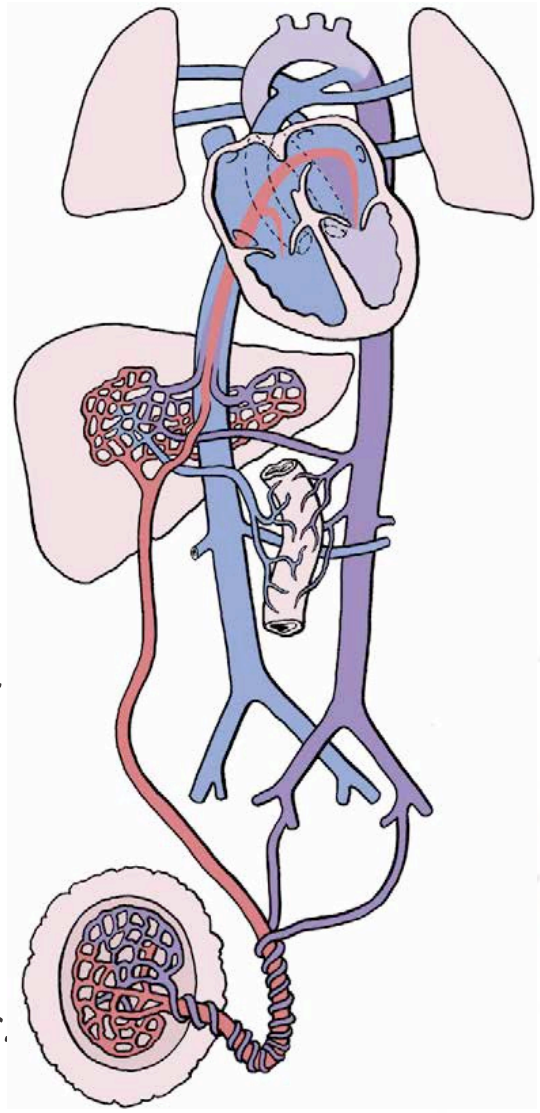


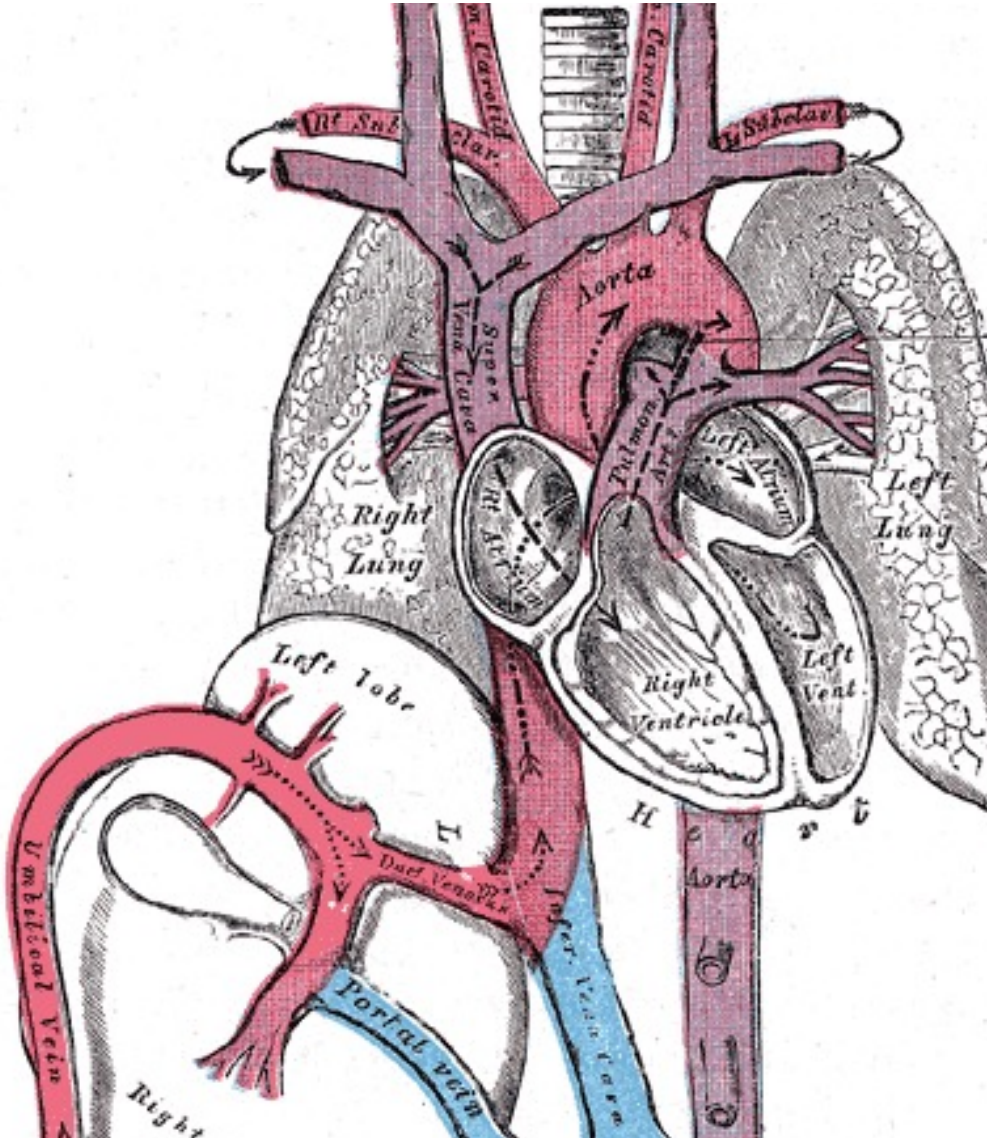
- **Septum interventriculare**
  - **Pars muscularis**
  - **Pars mebranacea**
  - **Septum atrioventriculare**
  - *Between LV and RA*

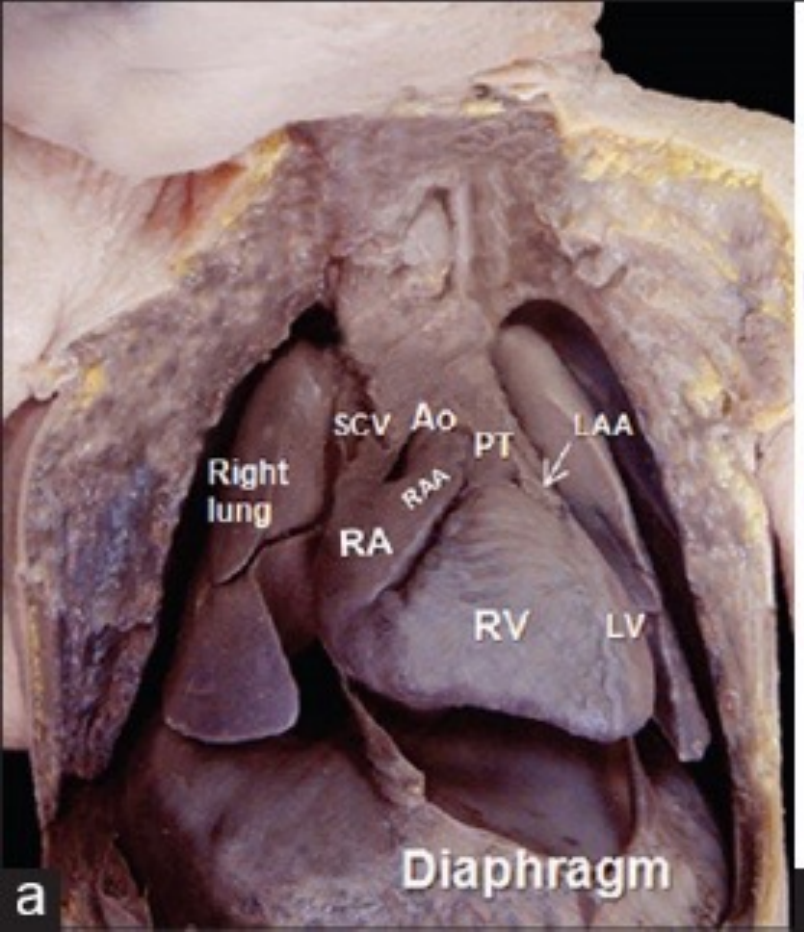
SEPTA CORDIS

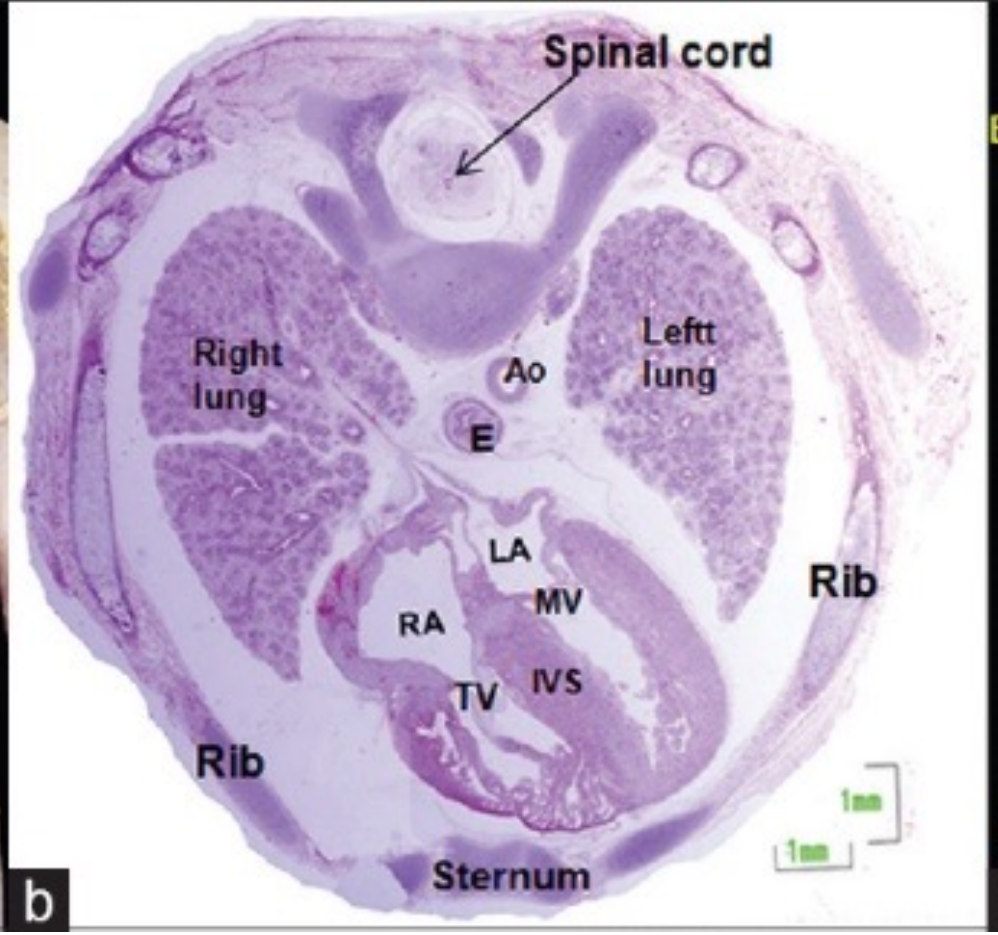
FETAL CIRCULATION

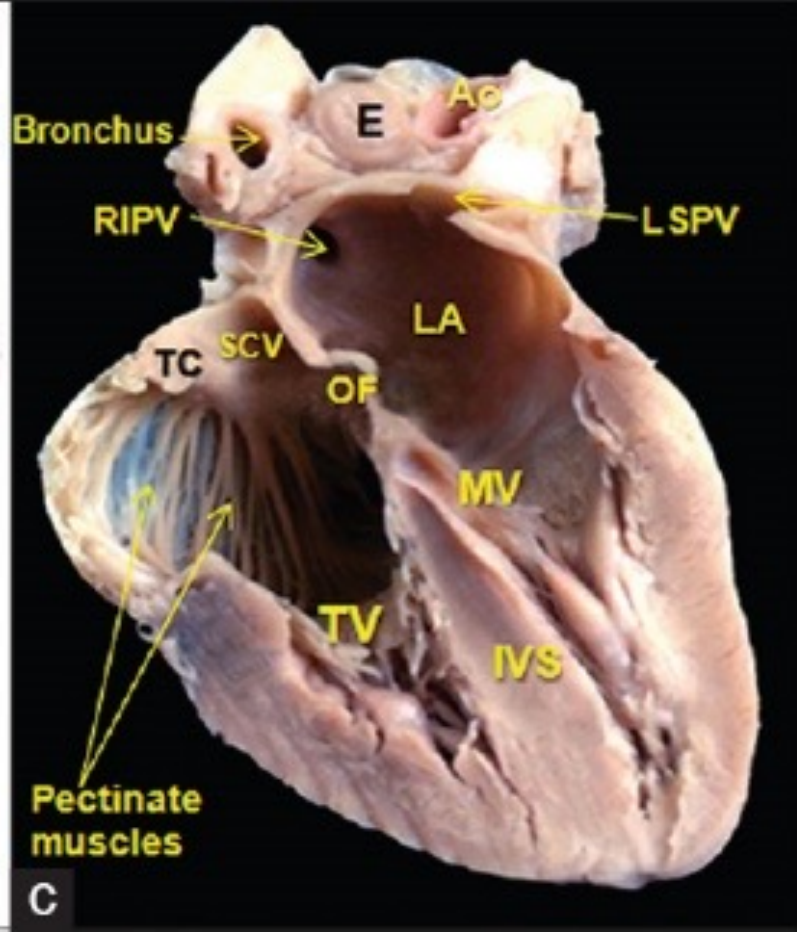
- **Placenta**
- **Umbilical cord - vasa umbilicales**
  - **V. umbilicalis – oxygenated blood**
  - **Aa. umbilicales – mixed blood**
- **Shunts**
  - *Oxygenated blood*
  - *into systemic circulation*
- **ductus venosus Arantii**
  - *from v. umbilicalis to v. cava inferior*
- **foramen ovale**
  - *From right to left atrium*
- **ductus arteriosus**
  - *From pulmonary trunc to aorta desc*







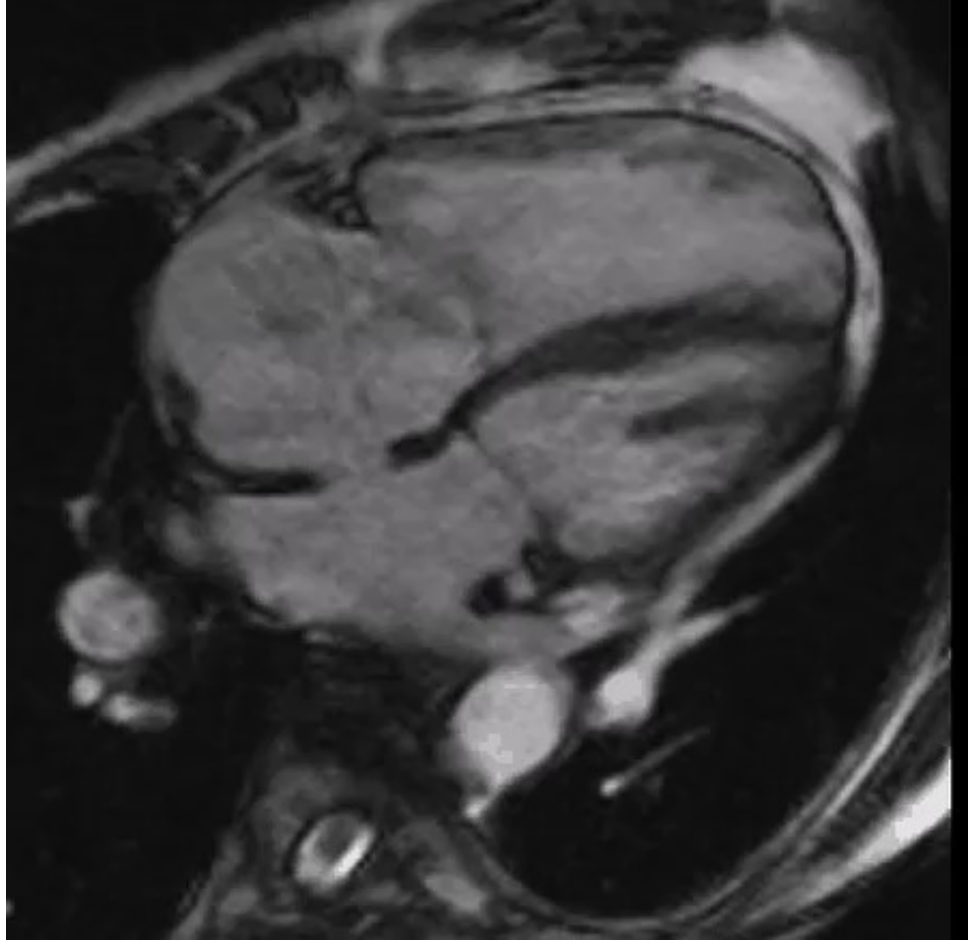


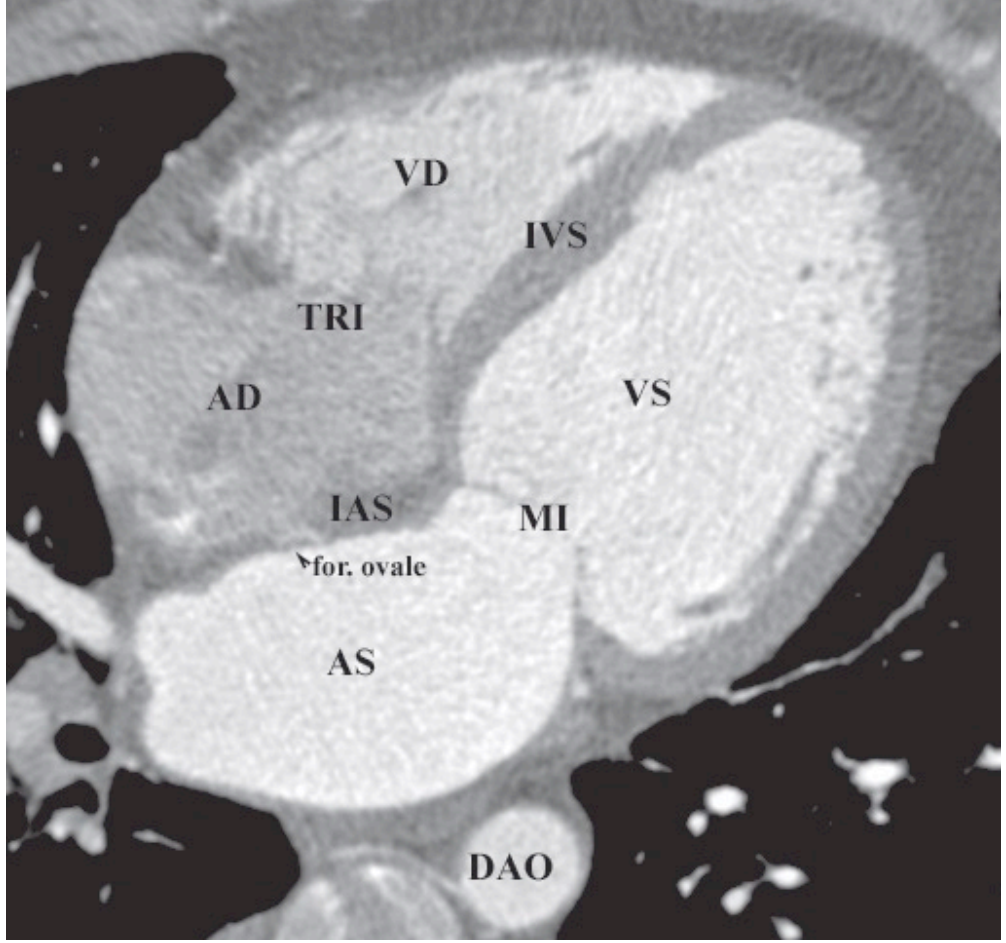


- opened foramen ovale
- Equal pressure - shunt between atria
- Ductus arteriosus Botalli - shunt 70-90%, Ductus venosus Arantii – blood bypasses liver

Beatriz Picazo-Angelin[1], Juan Ignacio Zabala-Argüelles[1], Robert H Anderson[2], Damian Sánchez-Quintana[3]Anatomy of the normal fetal heart: The basis for understanding fetal echocardiography, Annals of Pediatric Cardiologiy, 2018

FETAL HEART





- Foramen ovale patens x foramen ovale apertum
- Paradoxical embolism
- Eisenmenger syndrome

FORAMEN OVALE

DUCTUS ARTERIOSUS

- In adult - **ligamentum arteriosum**
- Point of fixation of aorta and pulmonry trunk

  deceleration – aortic tear

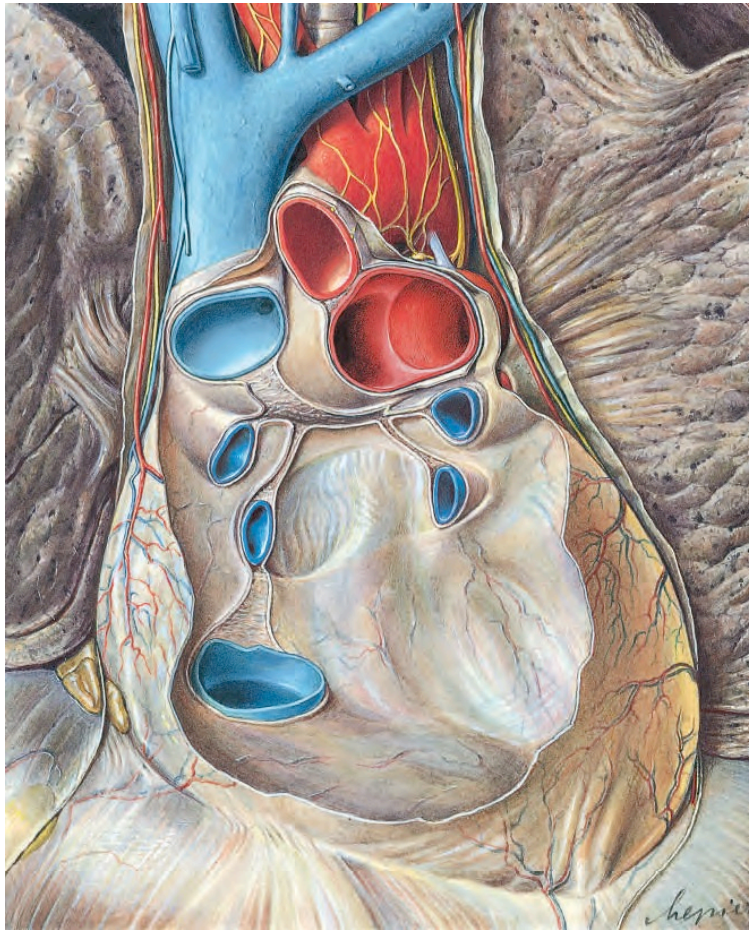
- Endocardium
  - Inner hydrofile surface
  - Valves
  - Chordae tendineae
- Myocardium - muscle
  - working myocard
  - conductive
- Pericardium
- Pericardium serosum visceralis - epicardium
  - Pericardium serosum parietalis
  - Cavitas pericardialis

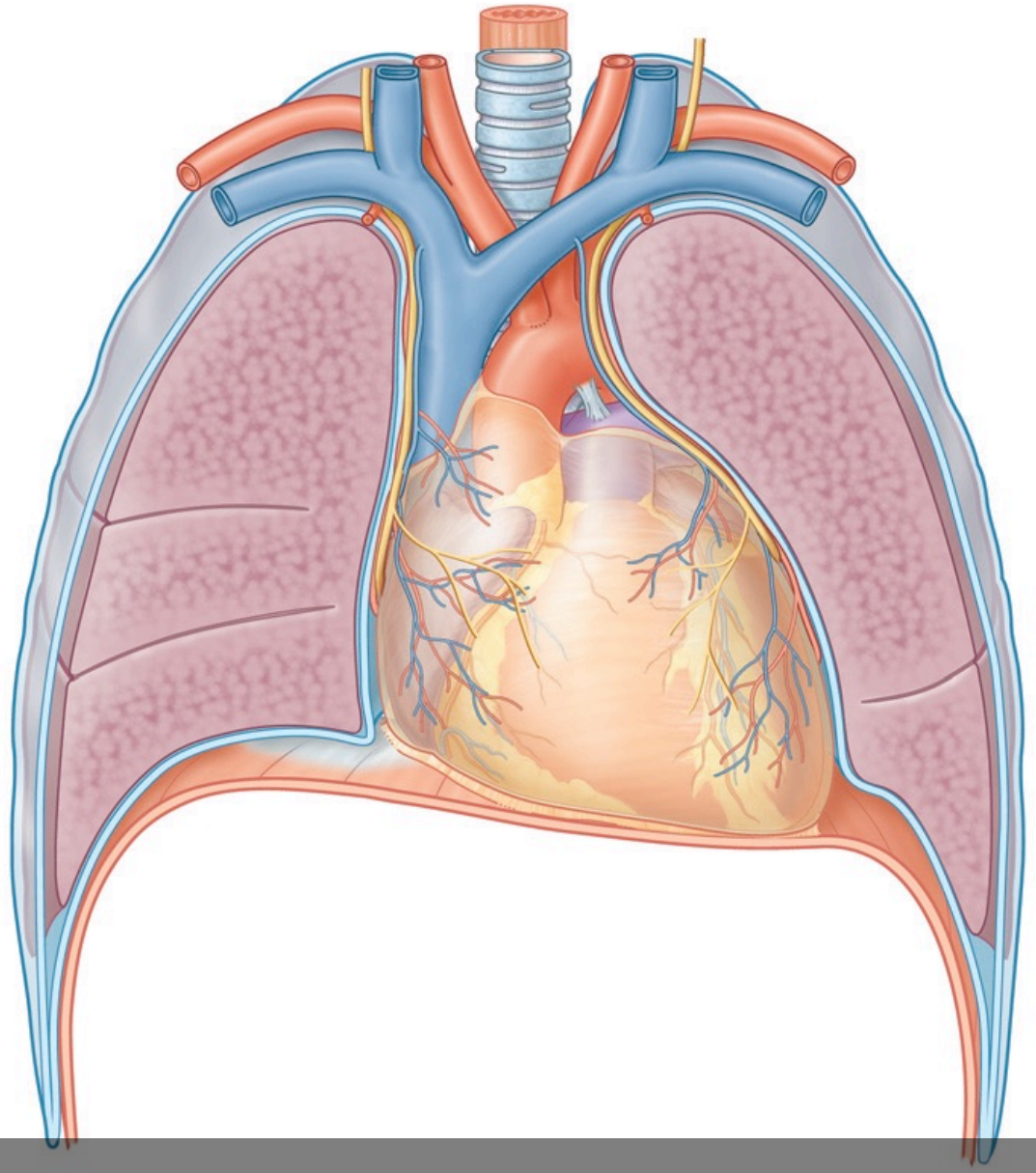
GENERAL CONCEPTION

PERICARDIUM

- Coelom cavity onlayered by mesothelium
- Epicardium – visceral sheet
- Pericardium – parietal sheet
- Enabling moving of the heart
- Recessus pericardiales along grat vessels

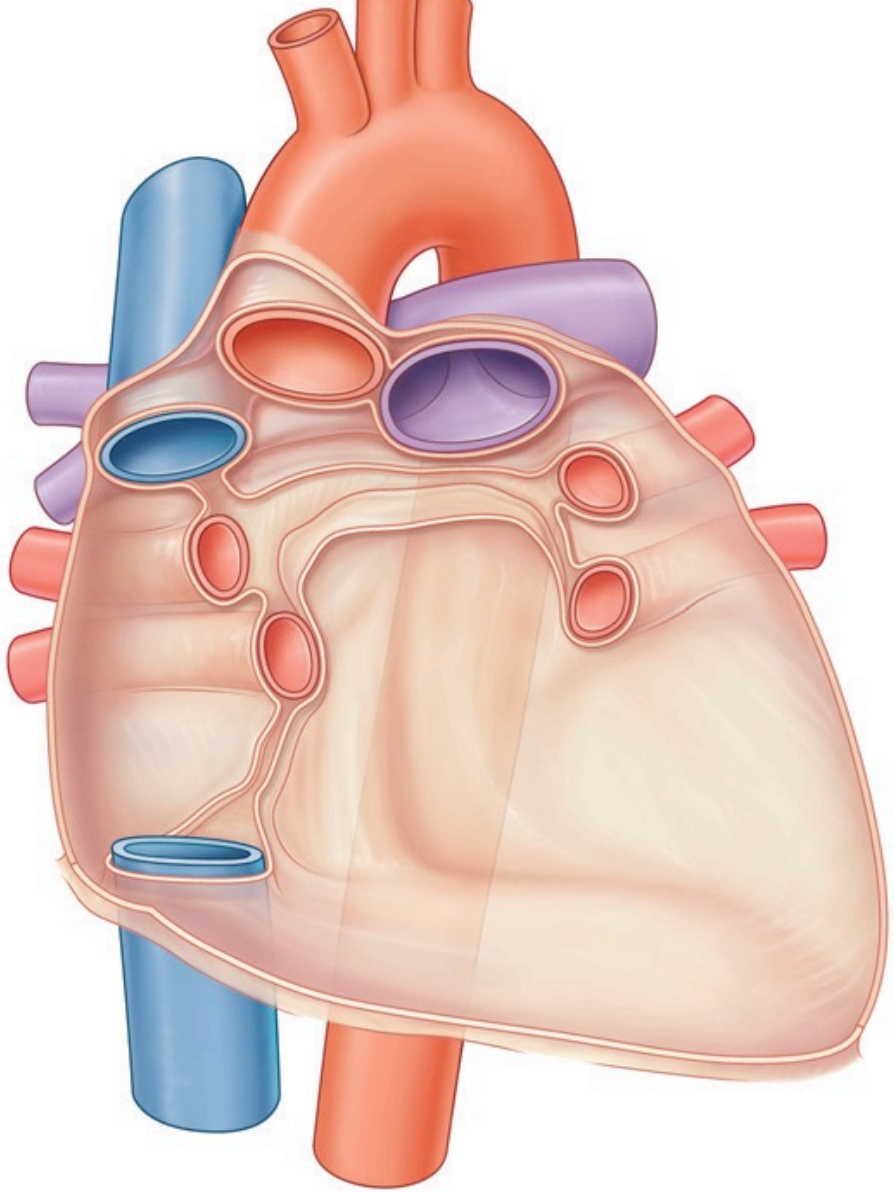
Pericardial fluid



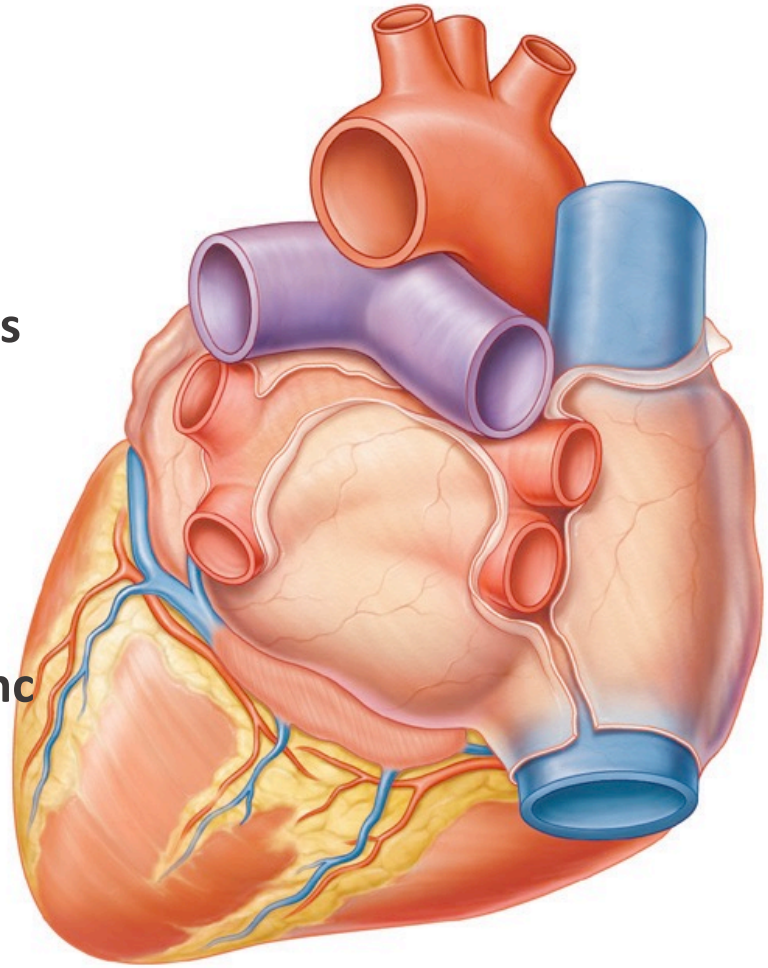


- Pericardium serosum visceralis - epicardium
  - Seu lamina visceralis
  - Containing fatty tissue, bed of vessels
- Pericardium serosum parietalis
  - with pericardium fibrosum forms lamina parietalis
  - Attached to fibrous pericardium
- Pericardium fibrosum
  - Following to adventitia of aorta + truncus pulmonalis
  - Following to anterior tracheal fascia
- Cavitas pericardialis
  - Film of fluid
  - Freedom to move
- Anchoring of pericardium
  - Lig. sternopericardiale superius et inferius
  - Centrum tendineum diaphragmatis

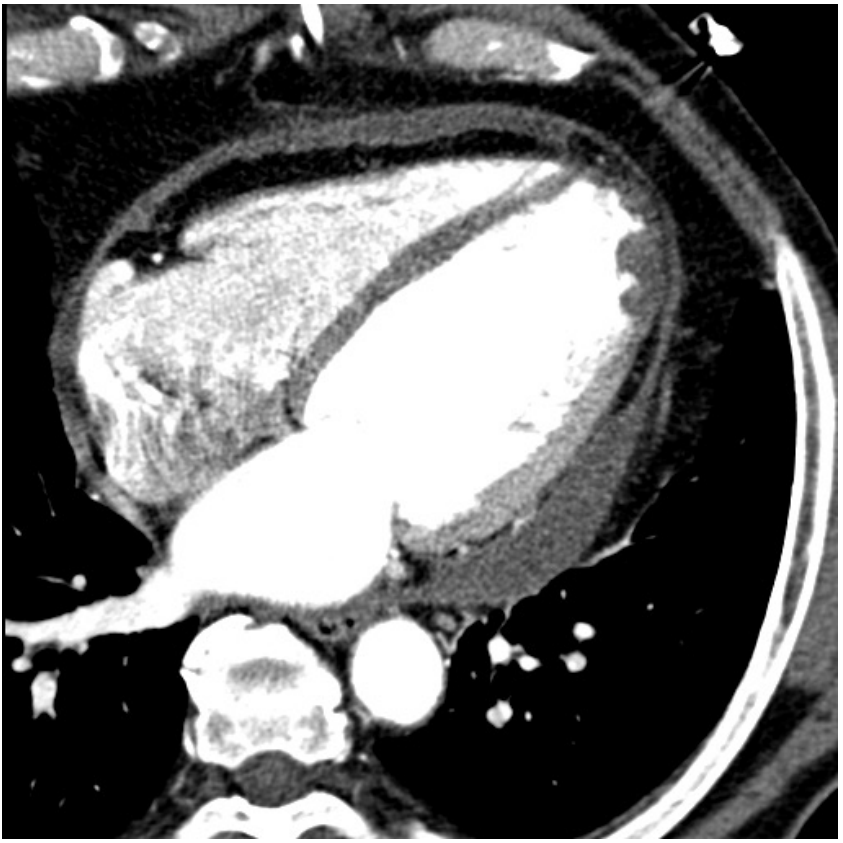
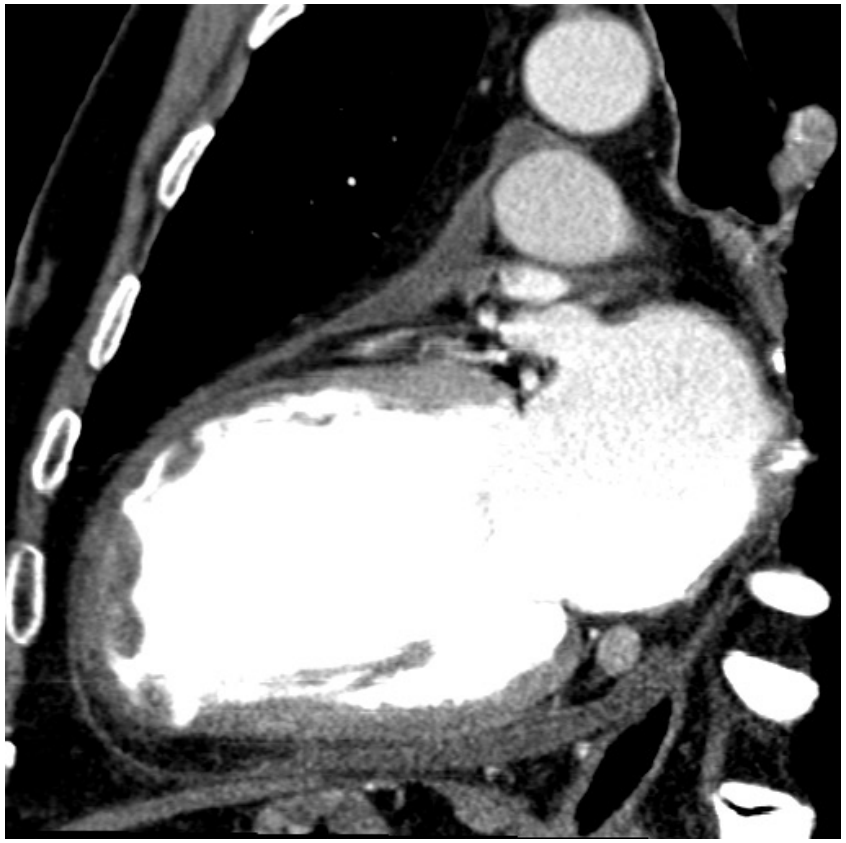
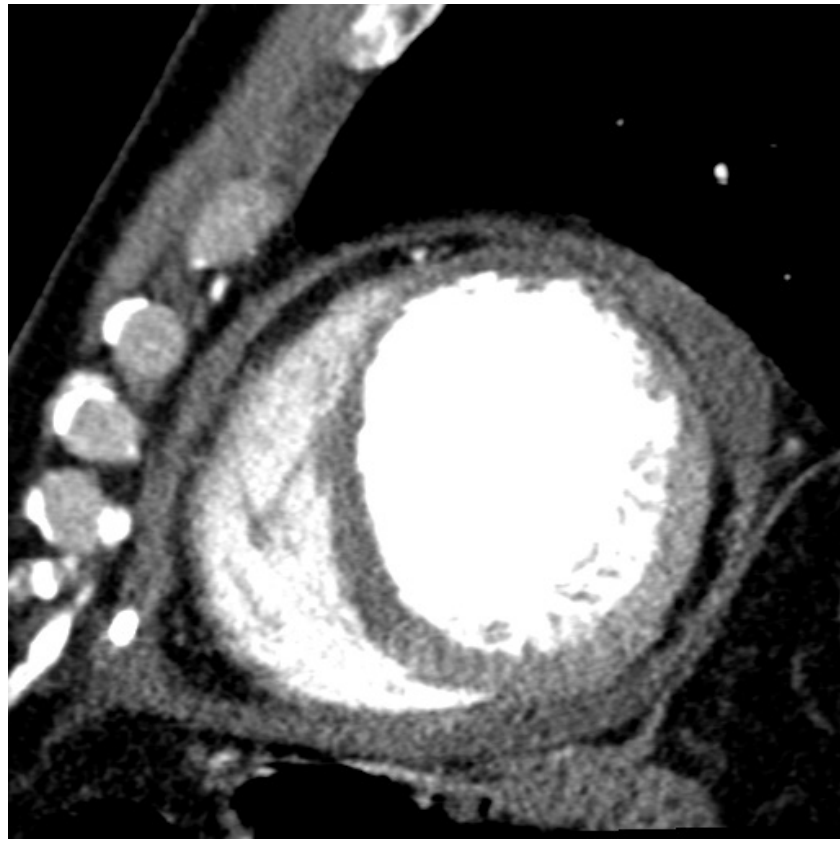
PERICARDIUM



- Porta venarum
  - horizontal T
  - Openings of caval veins
  - Openings of pulmonary veins
- Sinus obliquus pericardii
- Recessus postcavalis
- Vagina serosa arteriarum
  - Around aorta nad pulm. trunc
- Sinus transversus pericardii



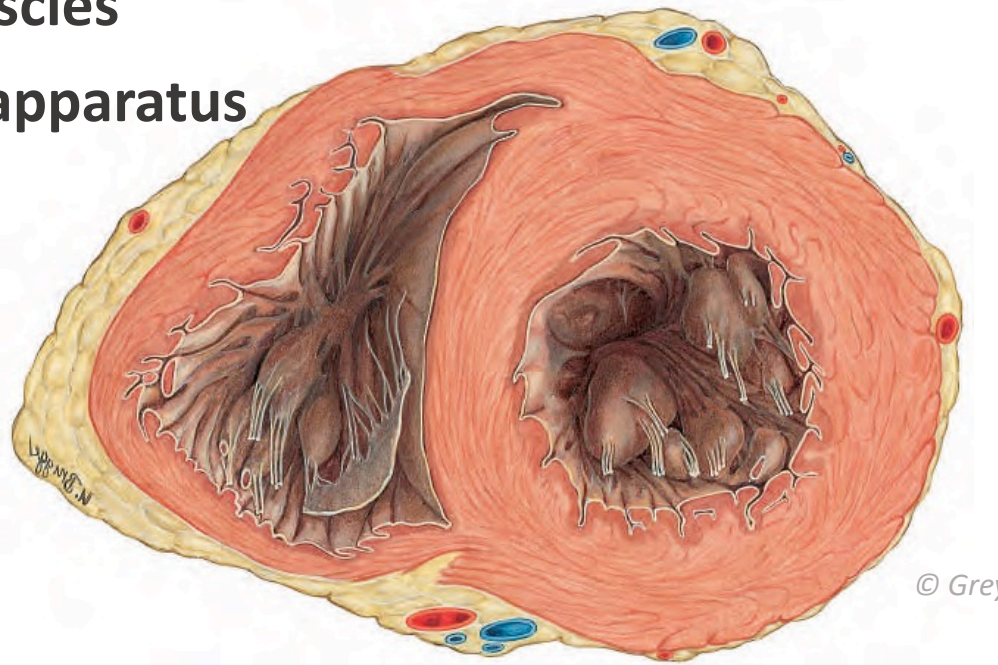
PERICARDIUM - RECESSUS

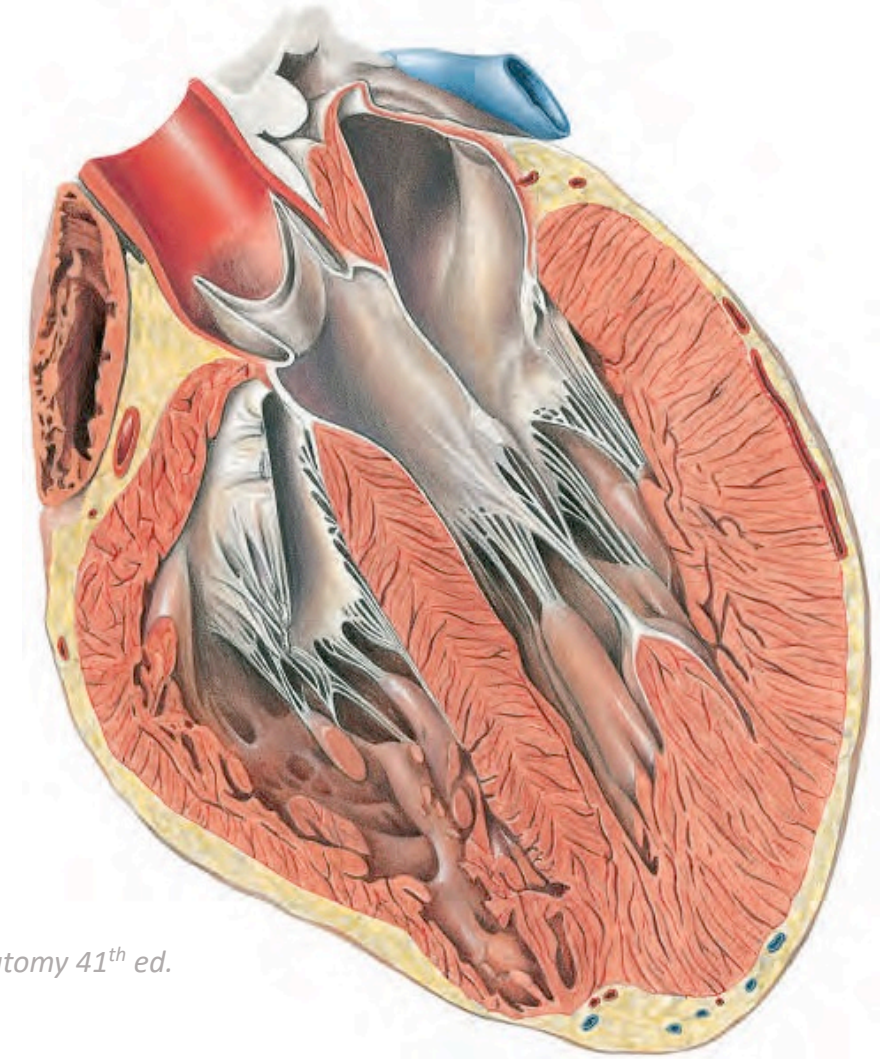




PERICARIAL FLUID

MYOCARDIUM

- Stripped muscular tissue with the bridges
- Veft ventricle
- Right ventricle
- Trabeculae
- Papillary muscles
- Conduction apparatus

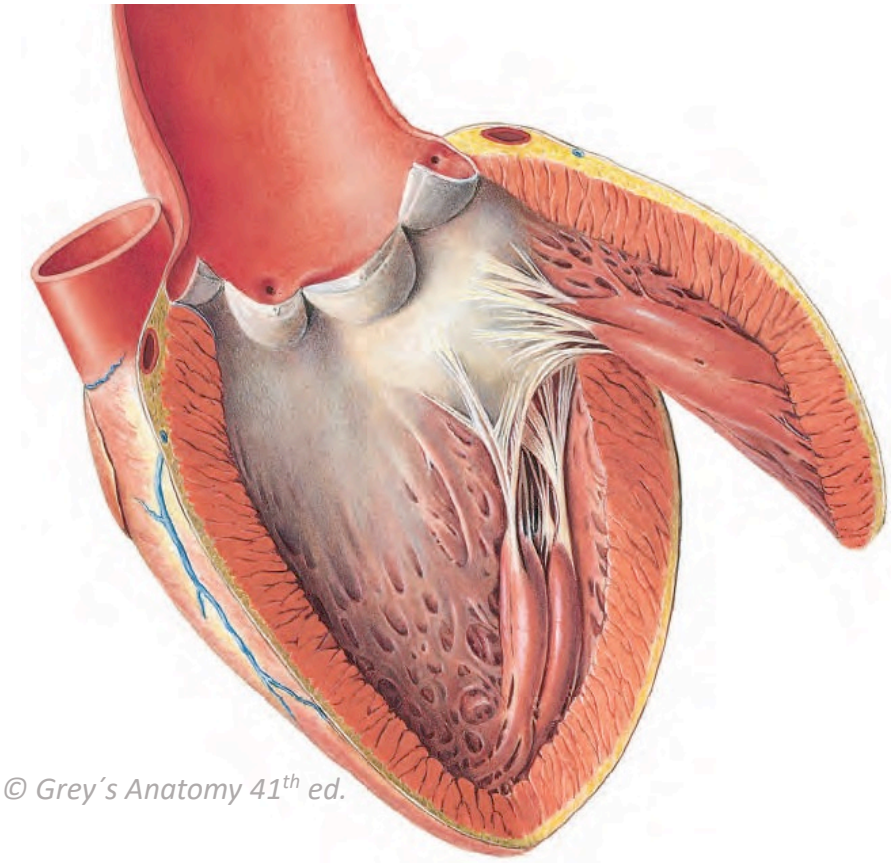


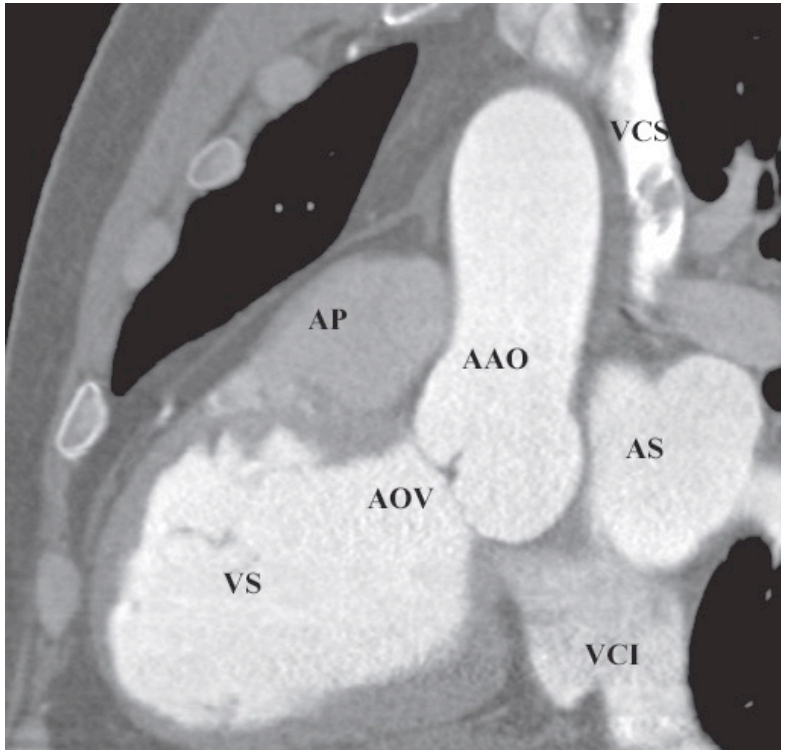


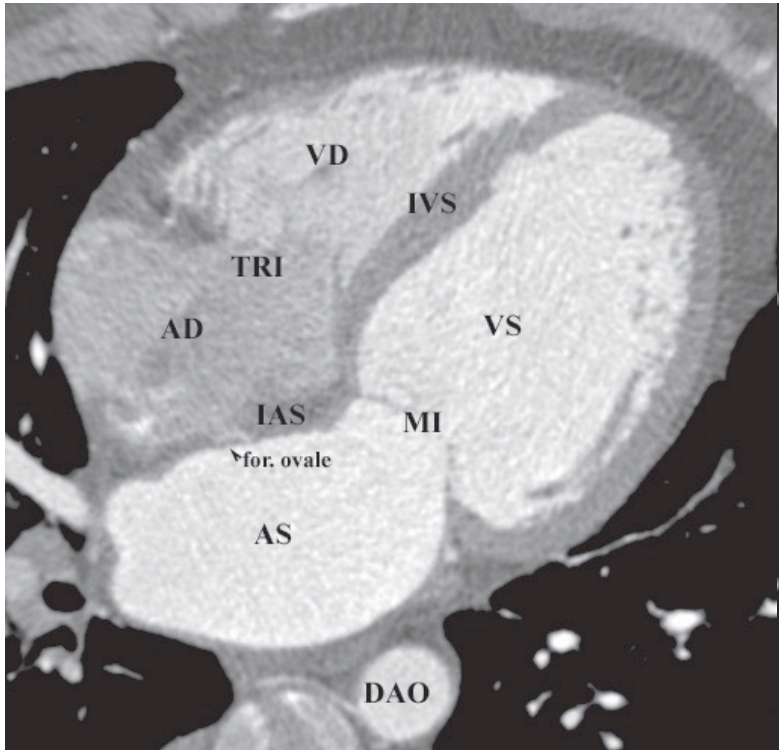
© Grey´s Anatomy 41th ed.

ENDOCARDIUM

- Inner surface of the atria nad ventricles – thin translucent membrane
- Valves, chordae tendinae

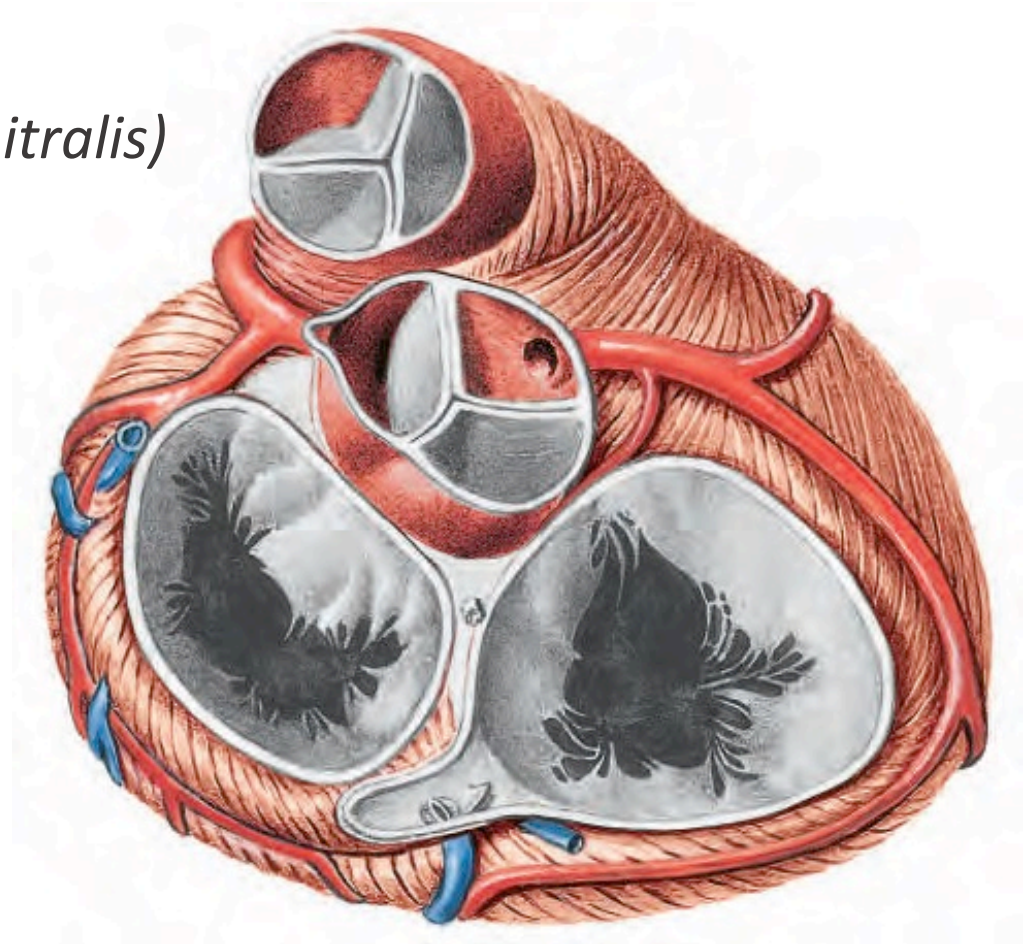


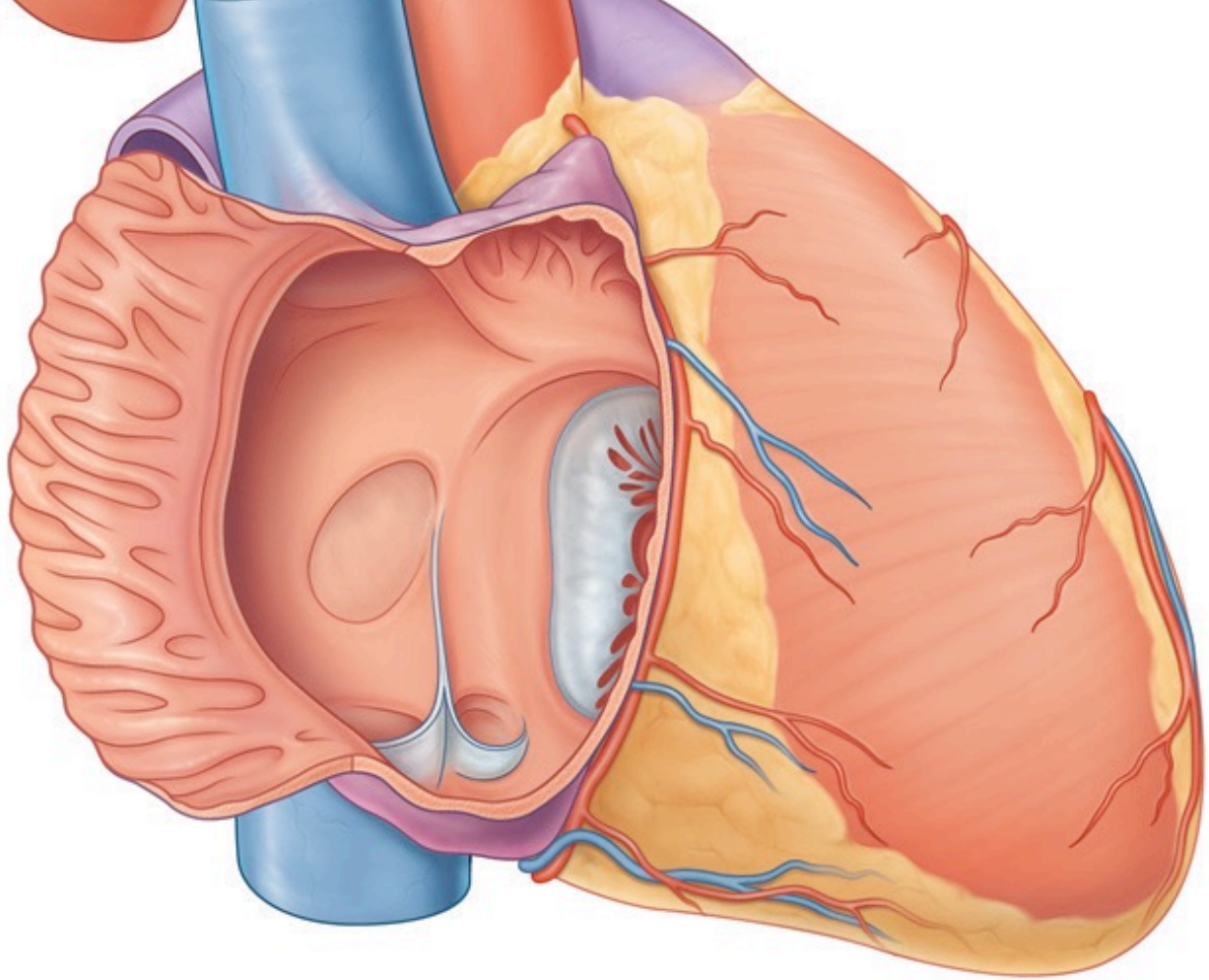




VALVAE CORDIS

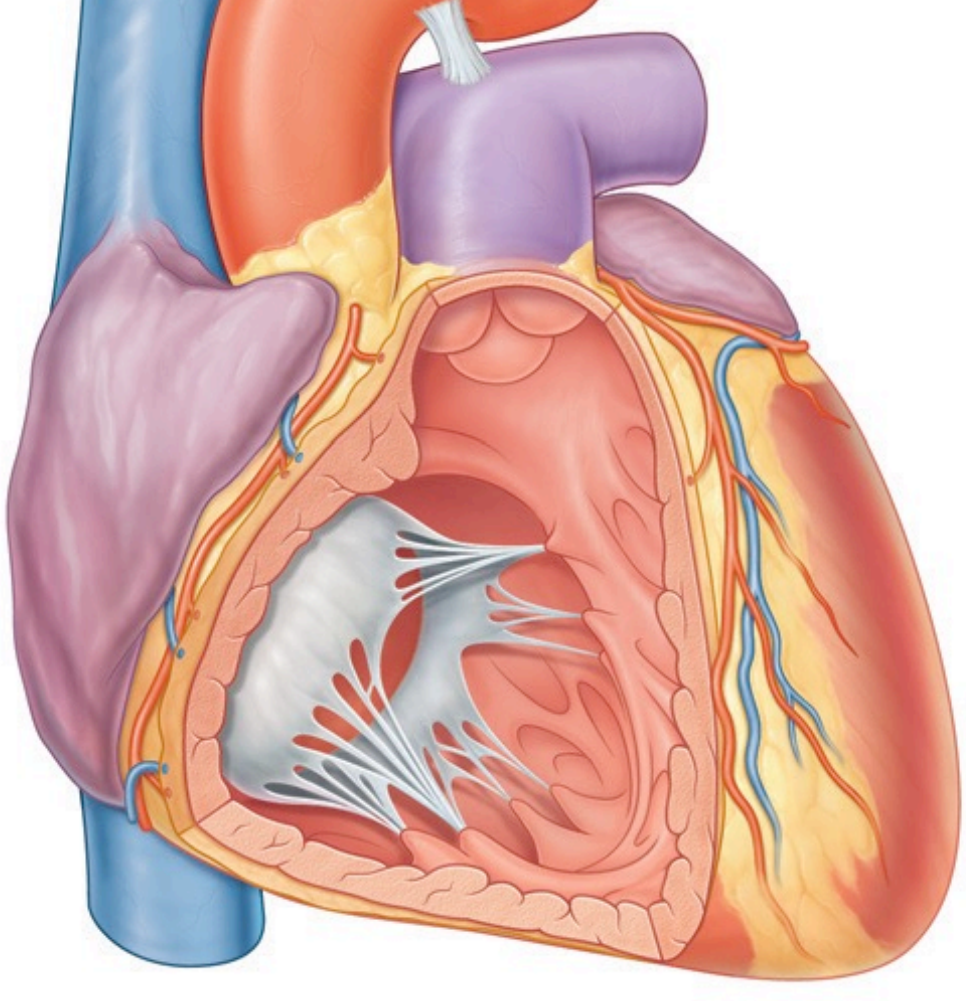
- **Valva**
- **Cuspis**
- *Valva atrioventricularis dexter (tricuspidalis)*
- *Valva atrioventricularis sinister (bicuspidalis seu mitralis)*
- *Valva aortalis*
- *Valva pulmonalis*





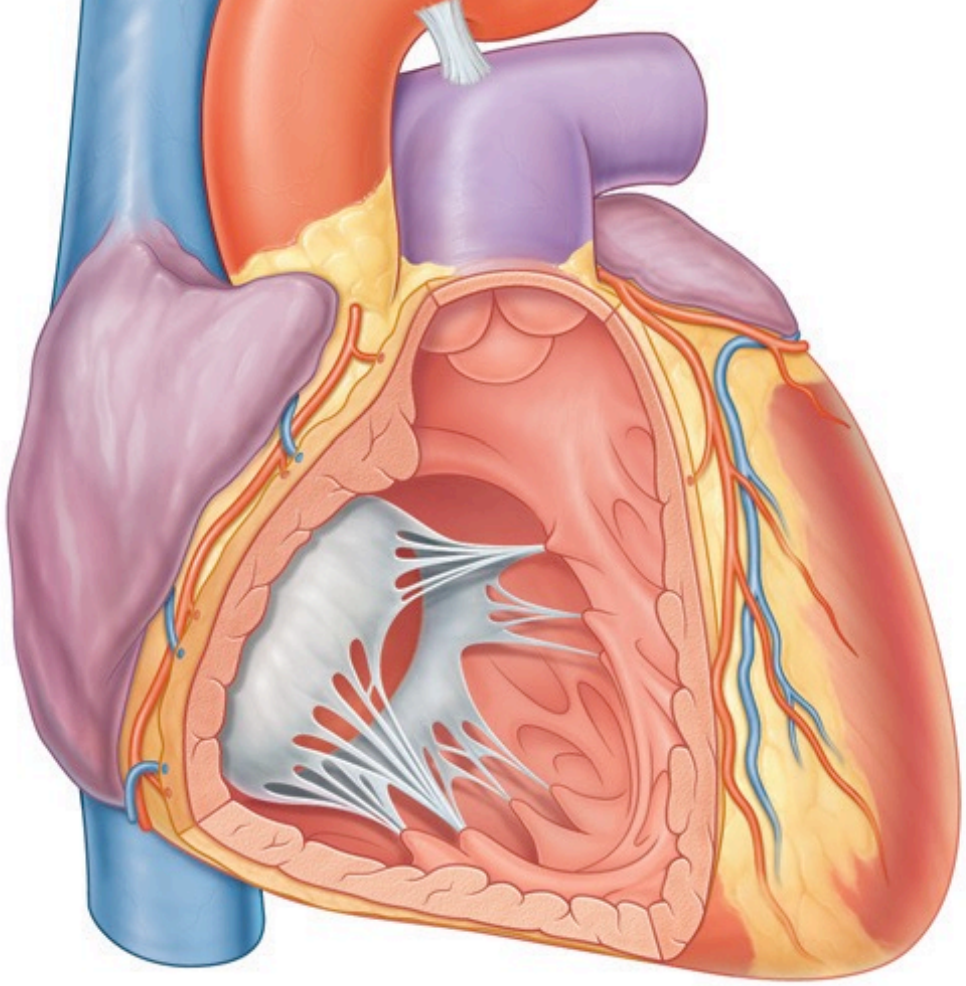
- opening venae cavae superior
- opening venae cavae inferior
  - Valva venae cavae inferioris
- opening sinus coronarius
  - Valva sinus coronarius
  - Tendo Todari (skeleton)
  - Triangulum Kochi - nodus atrioventricularis
    - Junction with ventricle
- Pars venosa (sinus venosus)
  - Smooth surface – lateral - nodus sinuatrialis
- Vestibulum valvae tricuspidalis
  - Ridges - mm. pectinati
- Auricula dextra
- Fossa ovalis (foramen ovale patens -1/3)

ATRIUM DEXTRUM



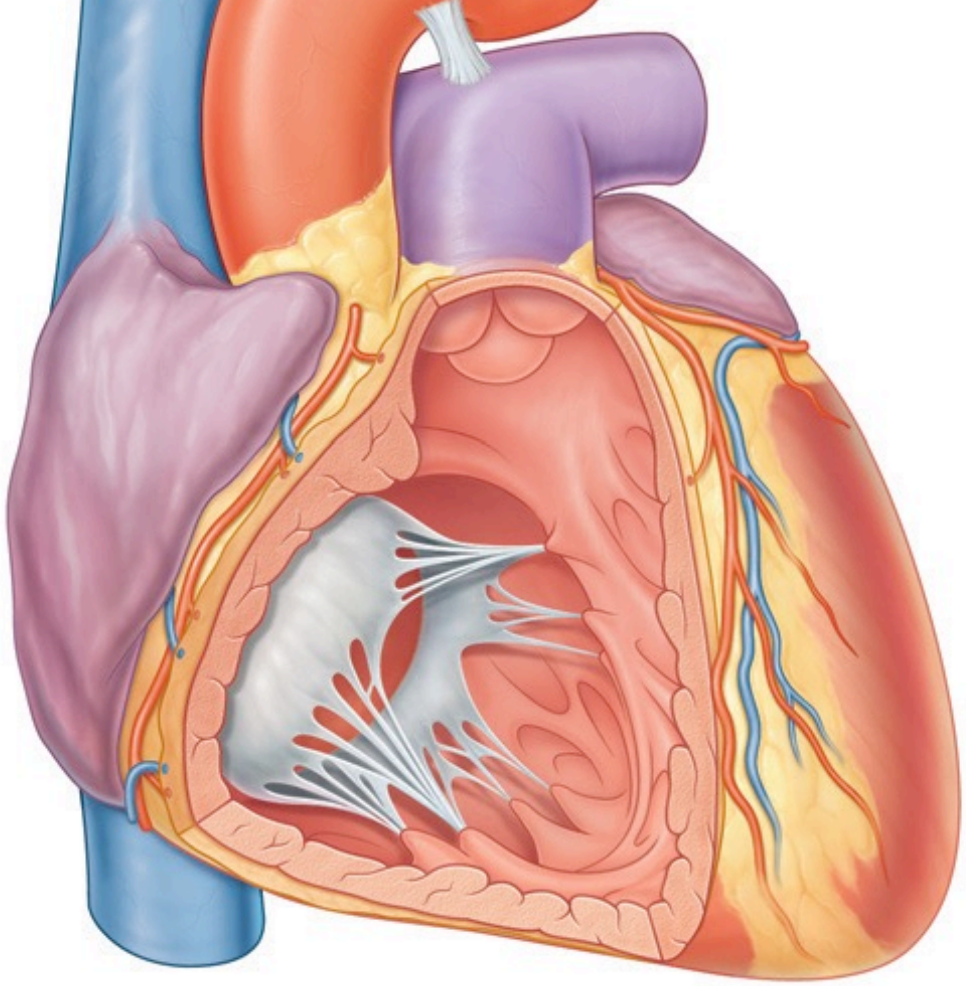
- Myocardium thickness 3-5 mm
  - Ratio RV:LV = 1:3
- Conus arteriosus (infundibulum)
- Trabeculae carneae
- Musculi papilares
  - Anterior, posterior, septalis
  - Chordae tendinae cuspides valvae tricuspidalis
- Trabecula septomarginalis
  - Bridge IV septum m. papillaris ant
  - Conduction for anerior wall
- Crista supraventricularis
  - Between valves
- Ligamentum infundibulare – conus tendon
  - conus arteriosus pulm. - radix aortae

VENTRICULUS DEXTER

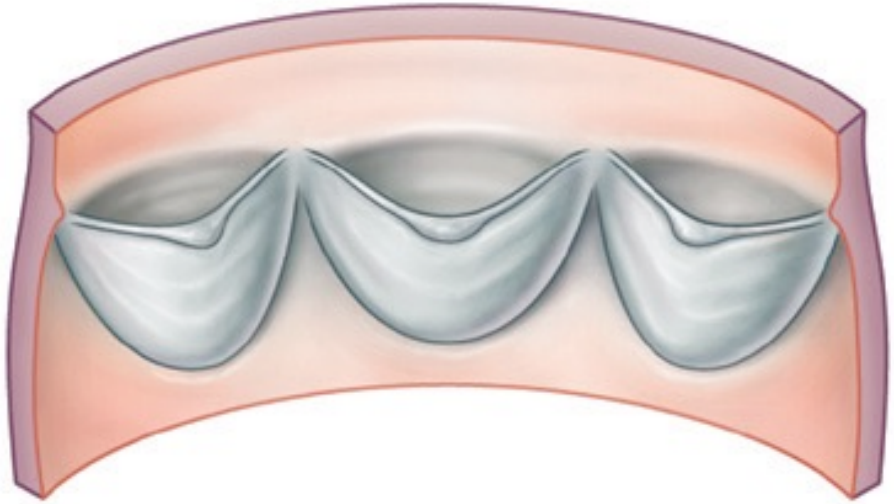


- Cuspis anterior
- Cuspis septal
- Cuspis posterior
  - chordae tendinae
  - Cuspis chrodae from two muscles
- Commisurae
- Anulus fibrosus

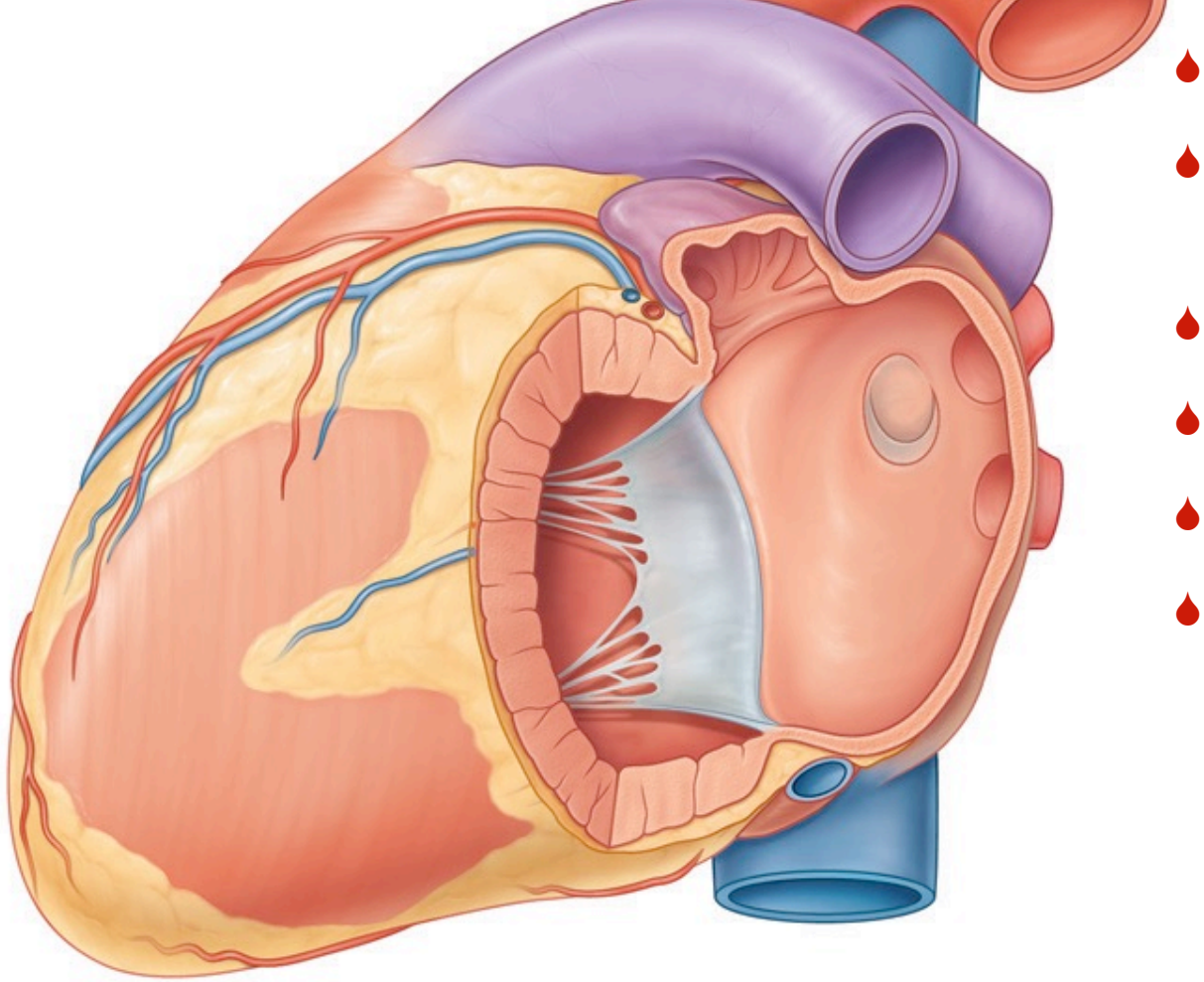
VALVA TRICUSPIDALIS



- Semilunaris
- Lunula
- Nodulus
- Sinus
  - Anterior
  - Sinister
  - Dexter

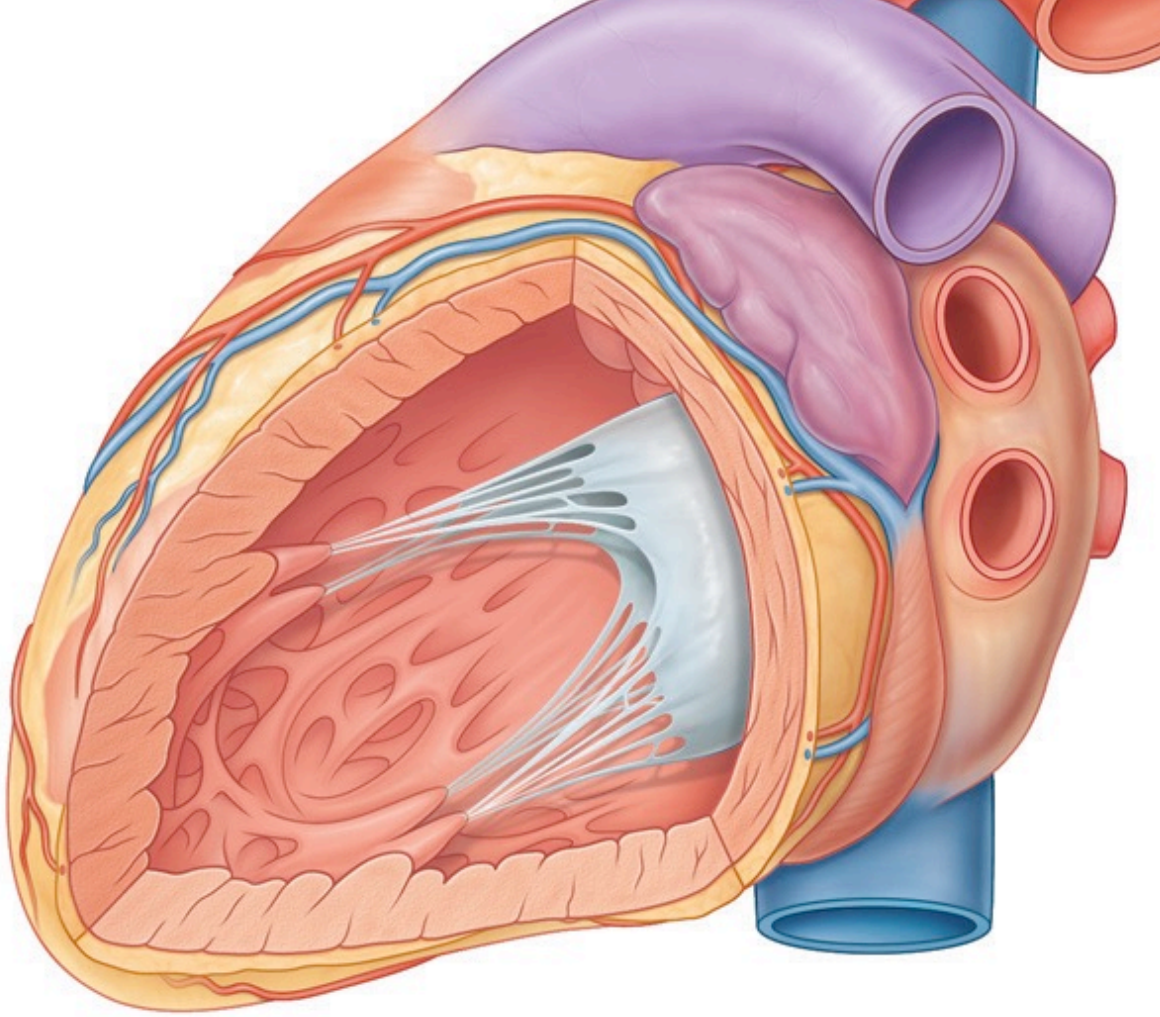


VALVA TRUNCI PULMONALIS



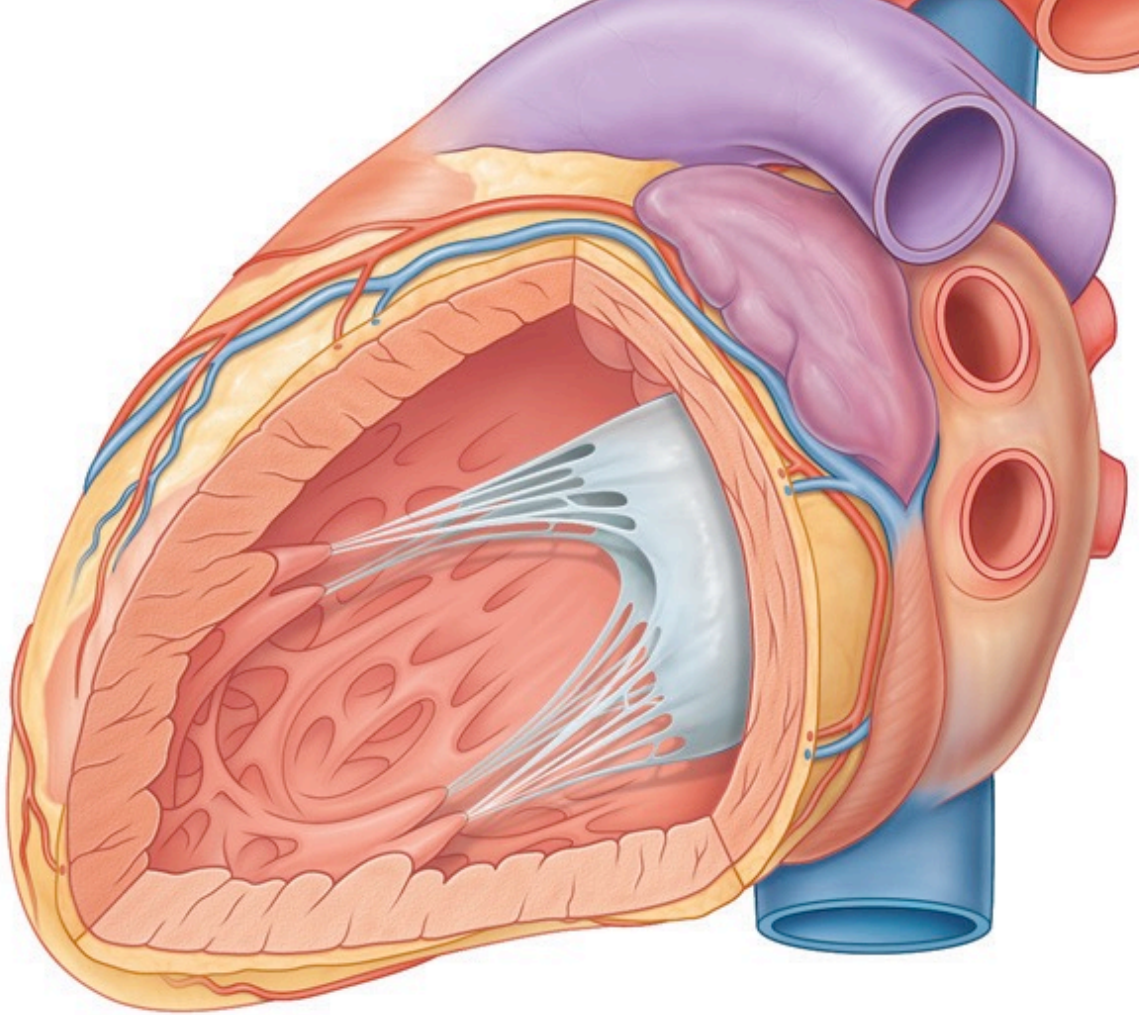
- Opening of four pulmonar veins
- Dorsal part immerges during fetal development into heart
- Anterior part – the own atrium
- Musculi pectinati
- Auricula
- Valva foraminis ovalis
  - embryonal

ATRIUM SINISTRUM



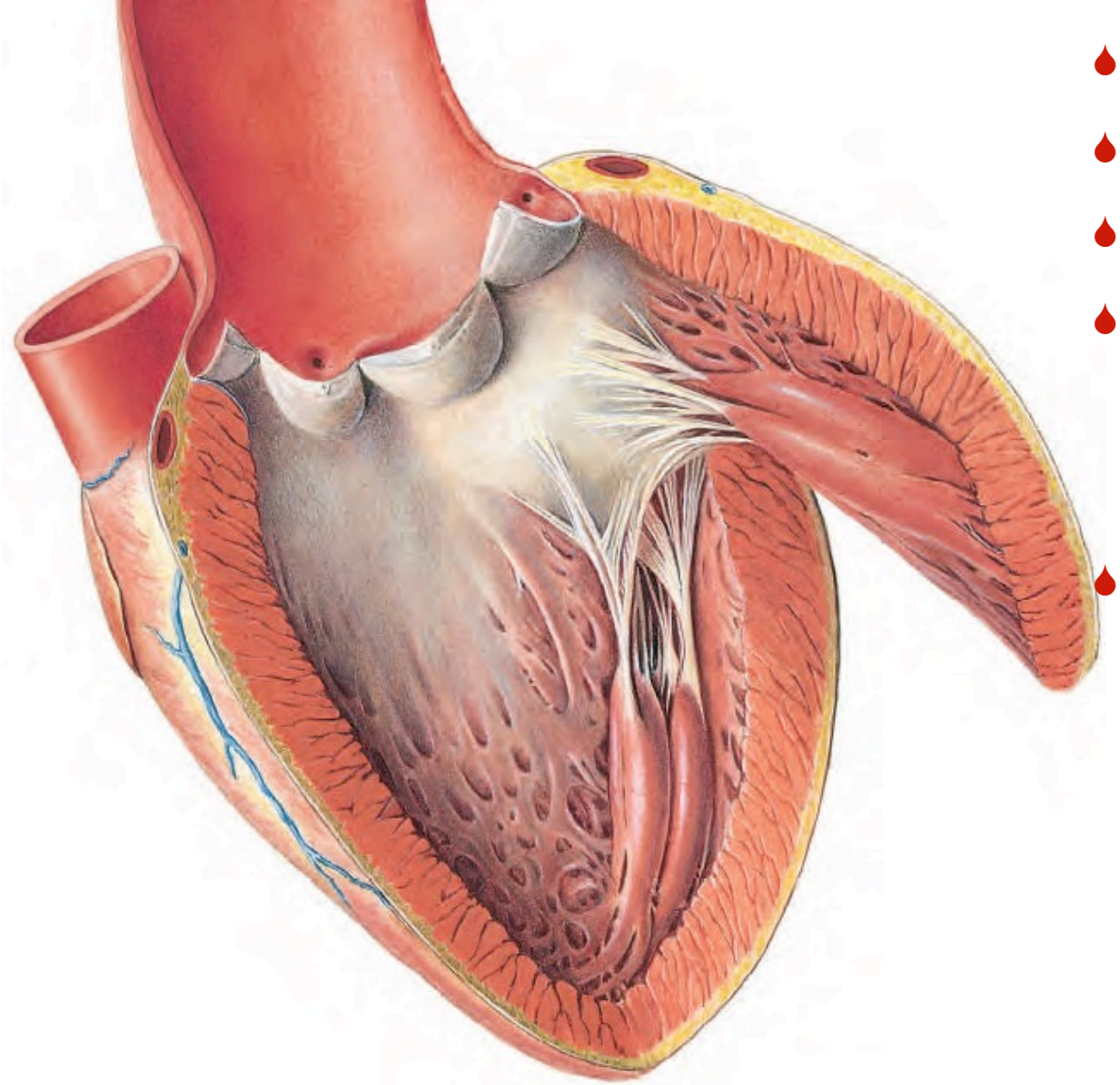
- Myocardium 8-12 mm
- Ostium atrioventriculare sinistrum
- Vestibulum aortae
- Trabeculae carneae
- Musculi papillares
  - Anterior
  - Posterior
  - Chordae tendineae
- Septum interventriculare
  - Pars muscularis
  - Pars membranacea
  - Septum atrioventriculare

VENTRICULUS SINISTER

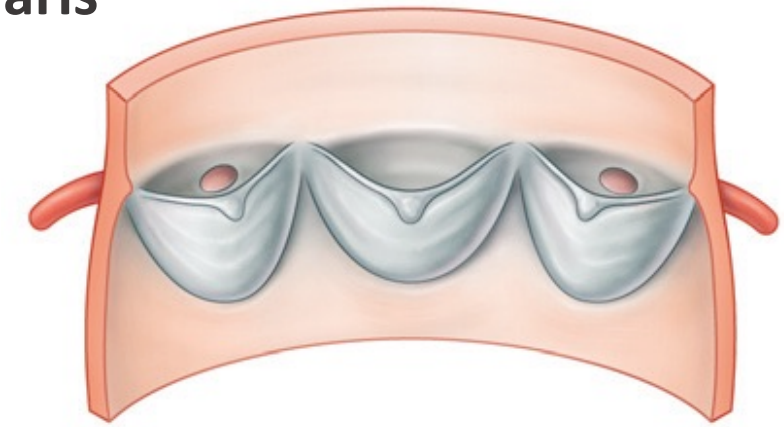


- Cuspis anterior
- Cuspis posterior
- Chordae tendinae
  - From both papillary muscles
- Comissurae
- Anulus fibrosus

VALVA ATRIOVENTRICULARIS SINISTRA

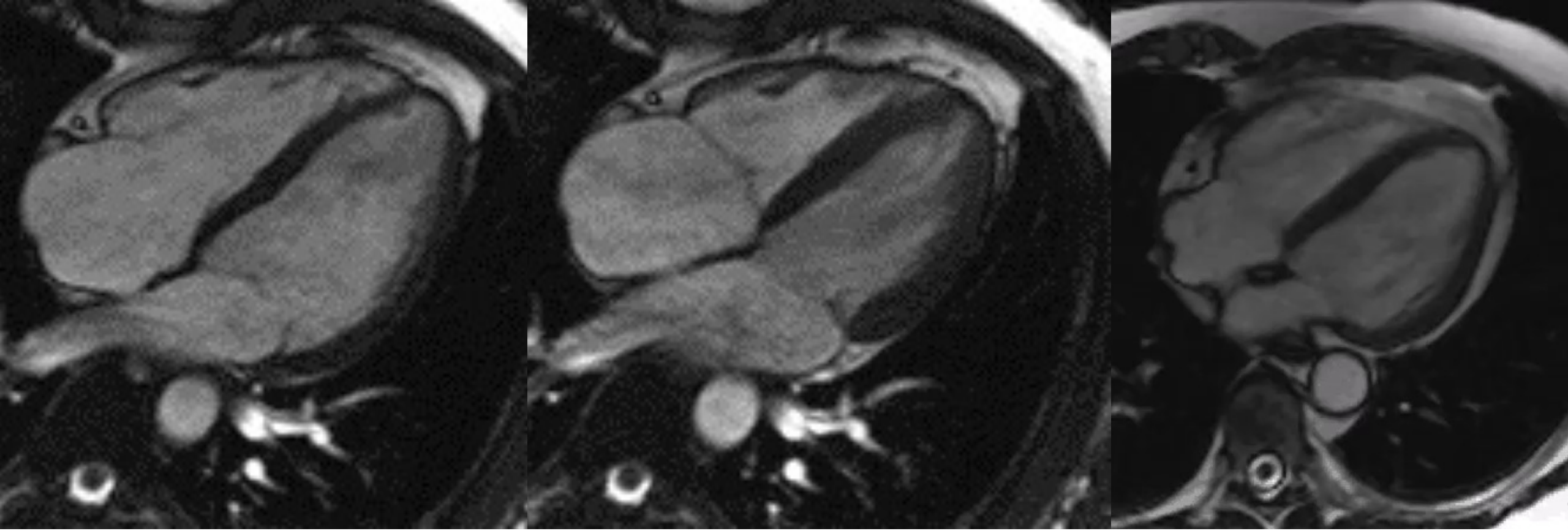


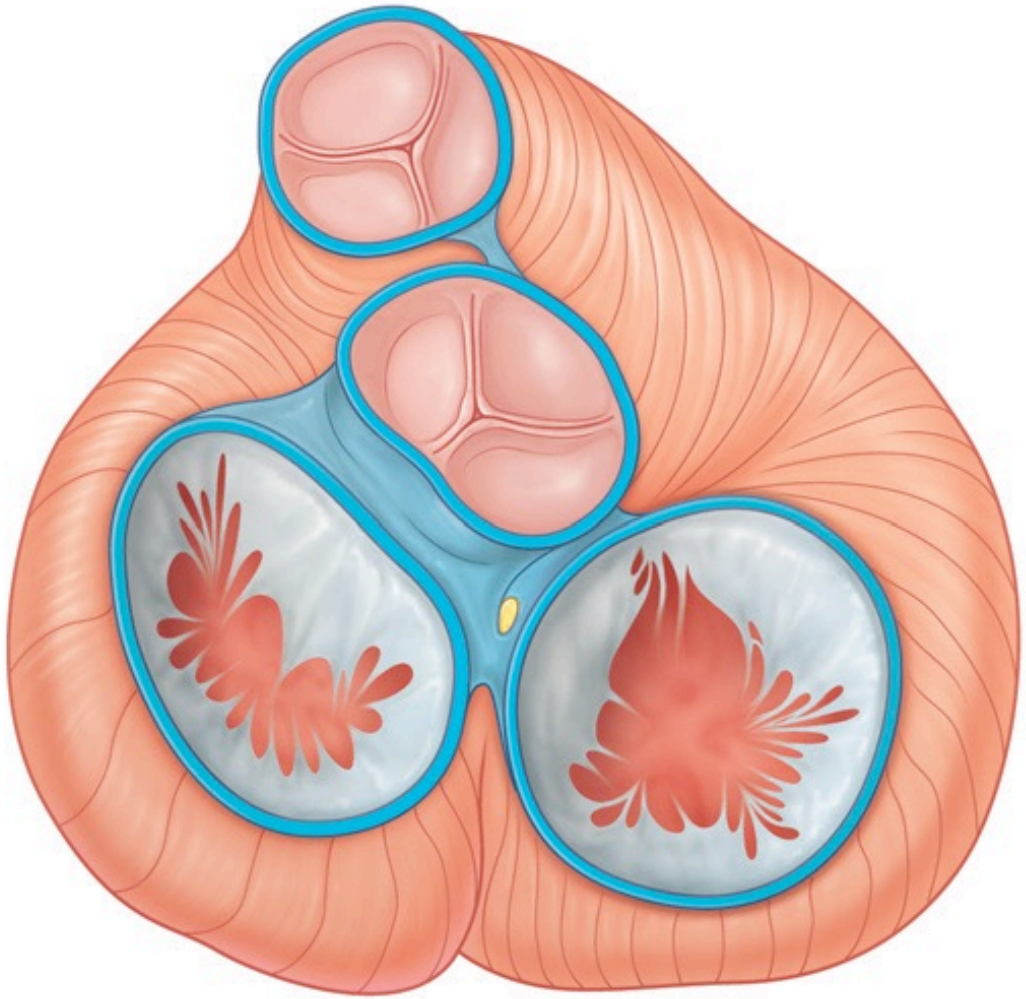
- Semilunaris
- Cuspis semilunaris
- Lunula
- Nodulus



- Sinus aorticus
  - (coronarius) sinister - a. coronaria sinsitra
  - (coronarius) dexter - a. coronaria dextra
  - Posterior (non-coronary)

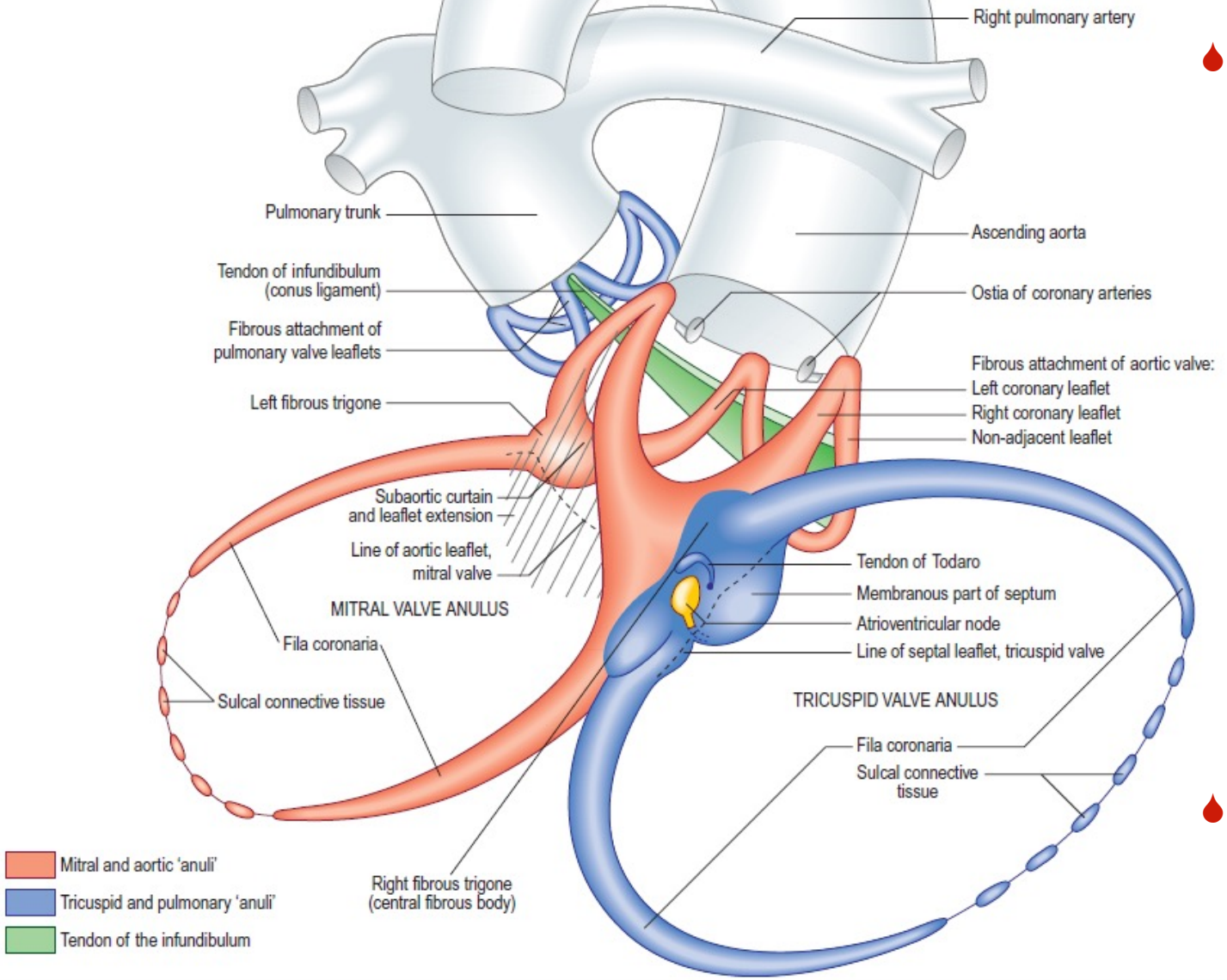
VALVA AORTAE





- **Anuli fibrosi (anulus fibrosus)**
  - **4 valves**
  - **Mitral and tricuspidal**
  - *Fila coronaria, sulcal connective tissue*
  - **Aortal and tr. pulmonalis**
  - *„coronet“*
  - *Conus ligament (ligamentum infundibuli)*
  - **Trigonum fibrosum dextrum**
  - *Opening for fasciculus atrioventricularis*
  - *Tendo Todara*
  - **Trigonum fibrosum sinistrum**
  - **Connection of mitral + aortal ring**
- **Skeleton of hte heart**
  - **Origin of the musculature**
  - **Electrical isolation**

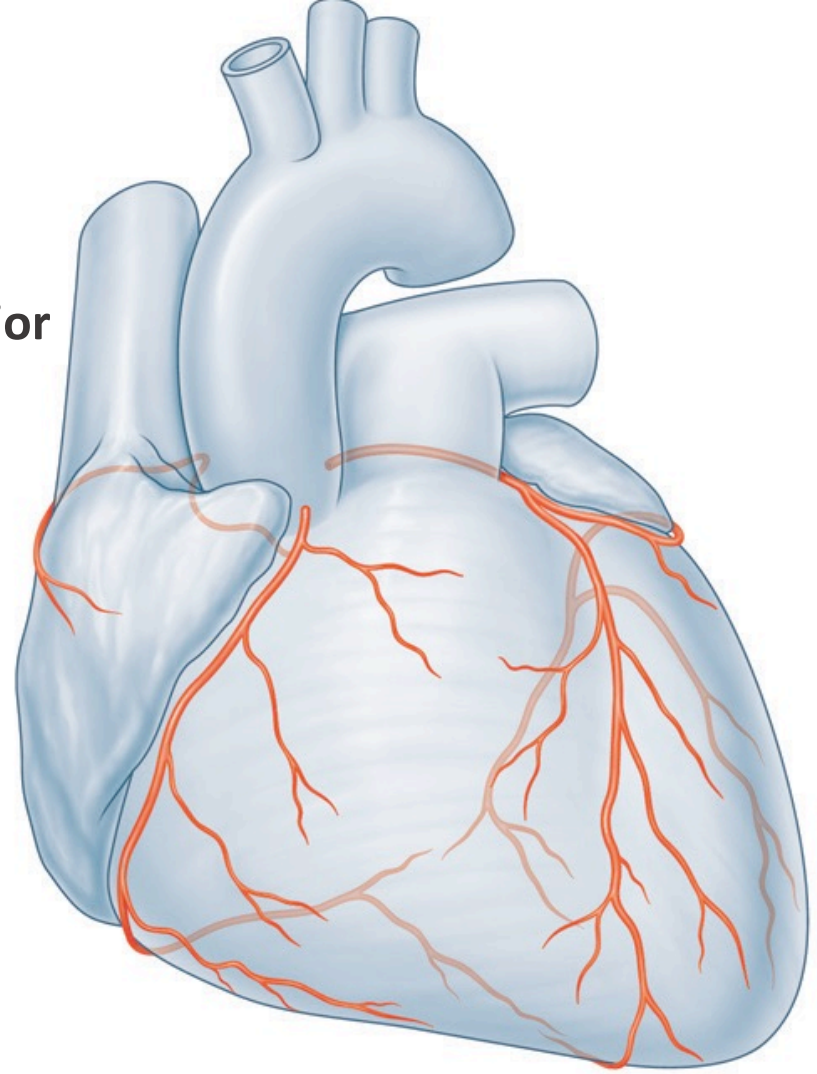
SKELETON CORDIS



- **Anuli fibrosi (anulus fibrosus)**
  - **4 valves**
  - **Mitral and tricuspidal**
  - *Fila coronaria, sulcal connective tissue*
  - **Aortal and tr. pulmonalis**
  - *„coronet“*
  - *Conus ligament (ligamentum infundibuli)*
  - **Trigonum fibrosum dextrum**
  - *Opening for fasciculus atrioventricularis*
  - *Tendo Todara*
  - **Trigonum fibrosum sinistrum**
  - **Connection of mitral + aortal ring**
- **Skeleton of hte heart**
  - **Origin of the musculature**
  - **Electrical isolation**

SKELETON CORDIS

- A. coronaria dextra
- A. coronaria sinistra
  - Stem
  - Ramus intervetricularis anterior
  - Ramus circumflexus



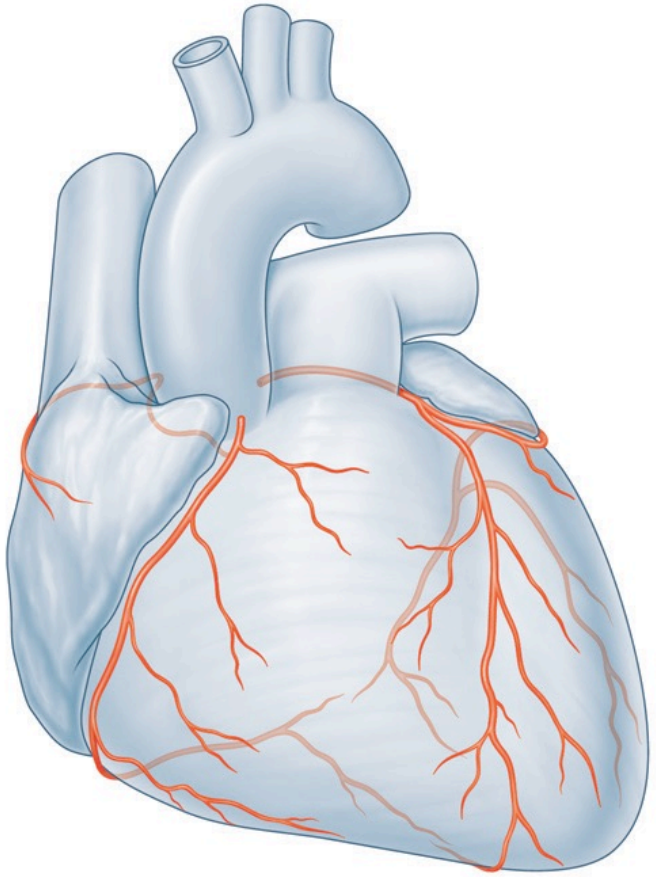
AA. CORONARIAE

- Ramus coni arteriosi
- Ramus ventricularis dexter
- Ramus marginalis dexter
- Ramus interventricularis posterior
- Ramus posterolateralis dexter

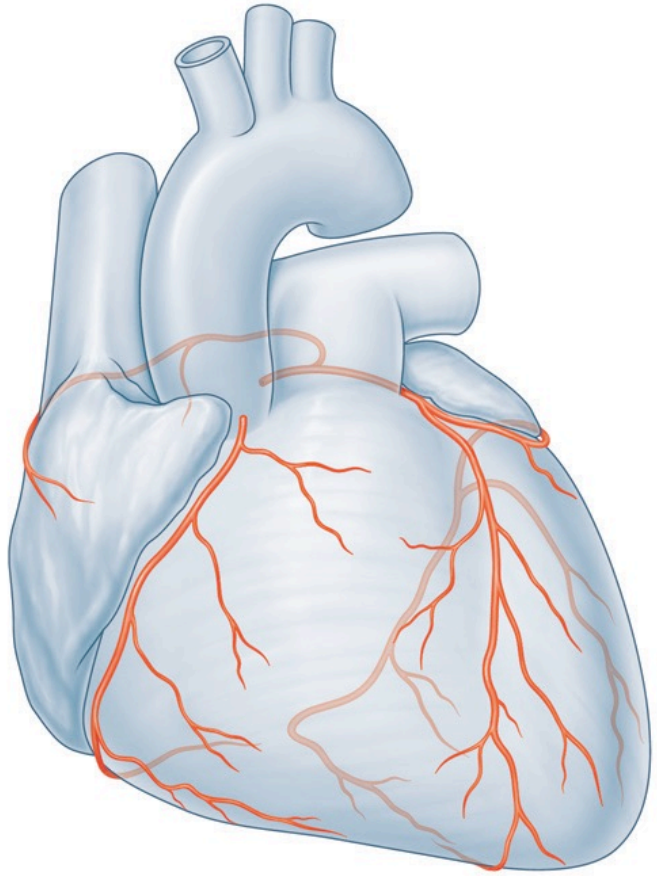
A. CORONARIA DEXTRA

- stem
- Ramus interventricularis anterior
- Ramus septalis
- Rami diagonales
- Ramus circumflexus
- Rami marginales
- Ramus posterolateralis sinister

A. CORONARIA SINISTRA

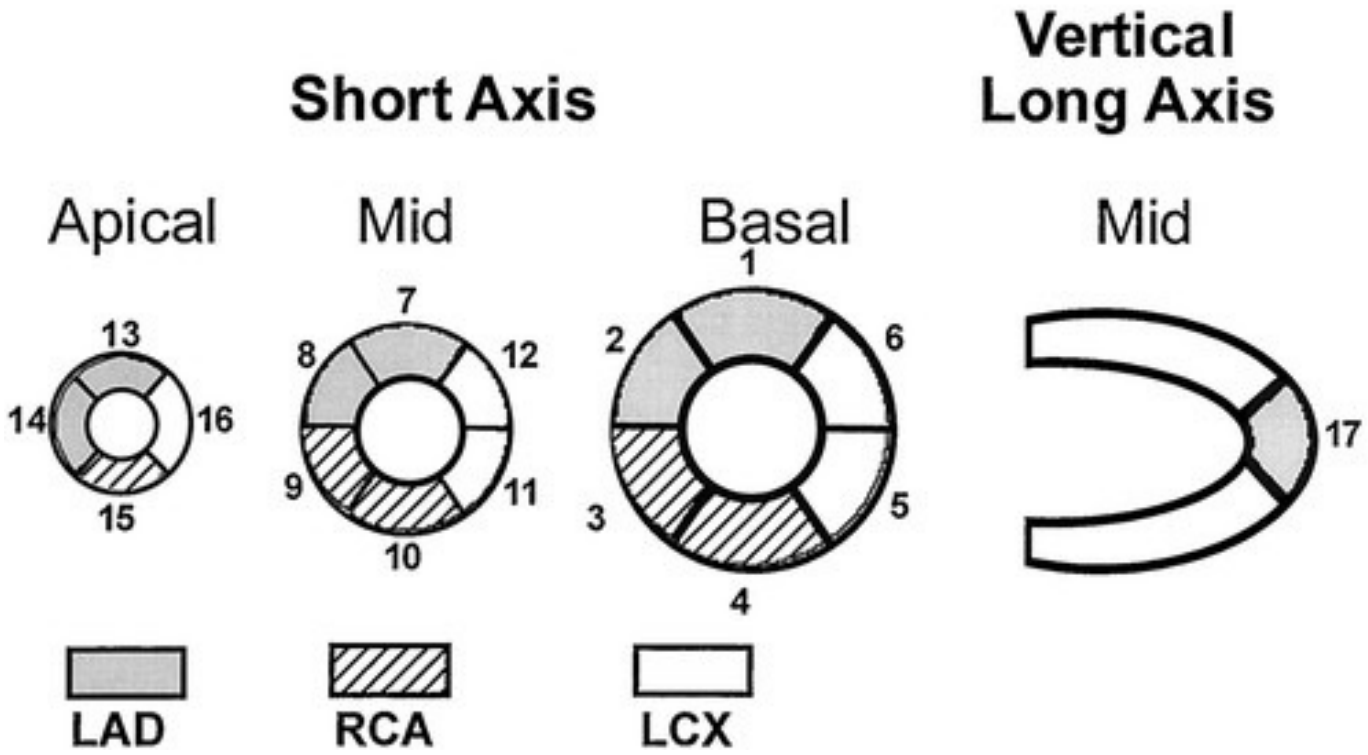


- Right dominant
- More frequent
- Ekvilibrial
- Left dominant

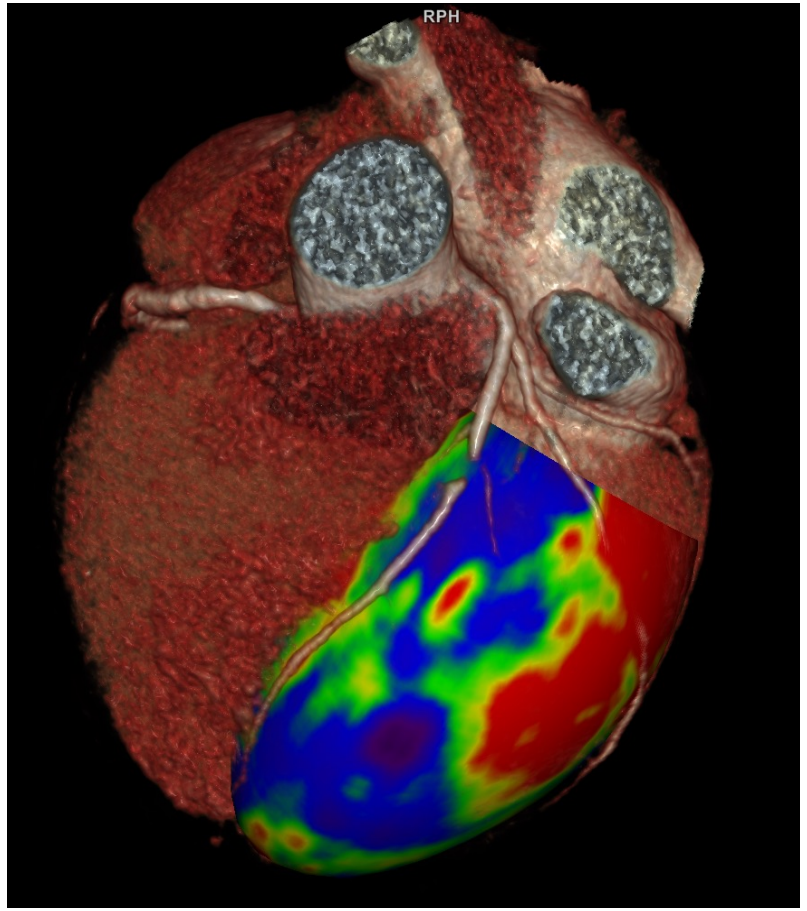


DOMINANCE

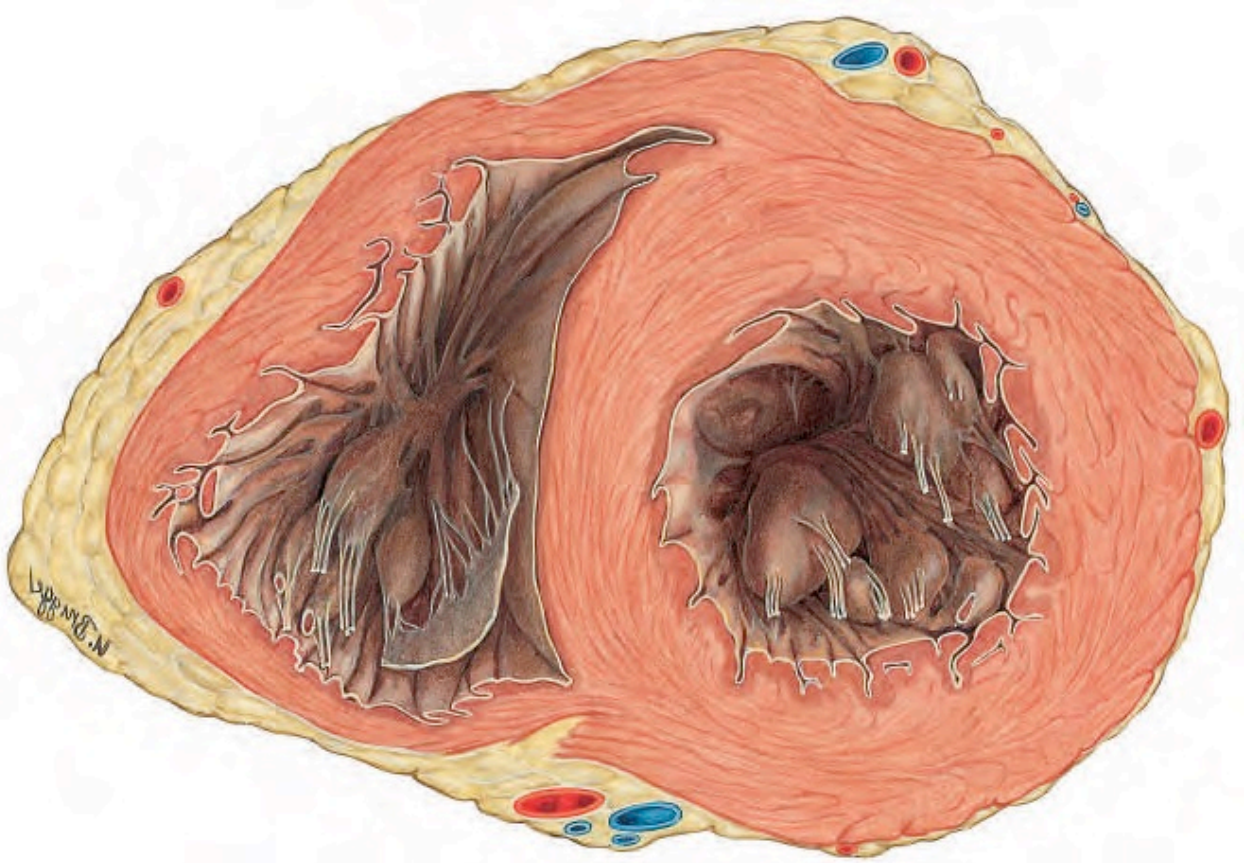
Coronary Artery Territories



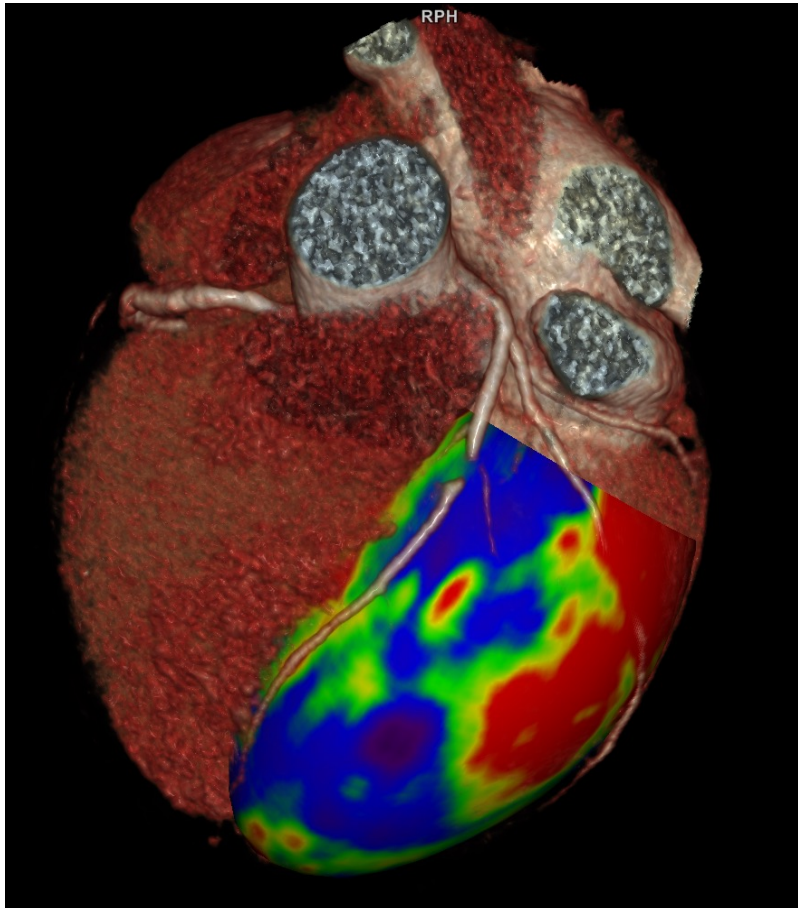
- Basic territories



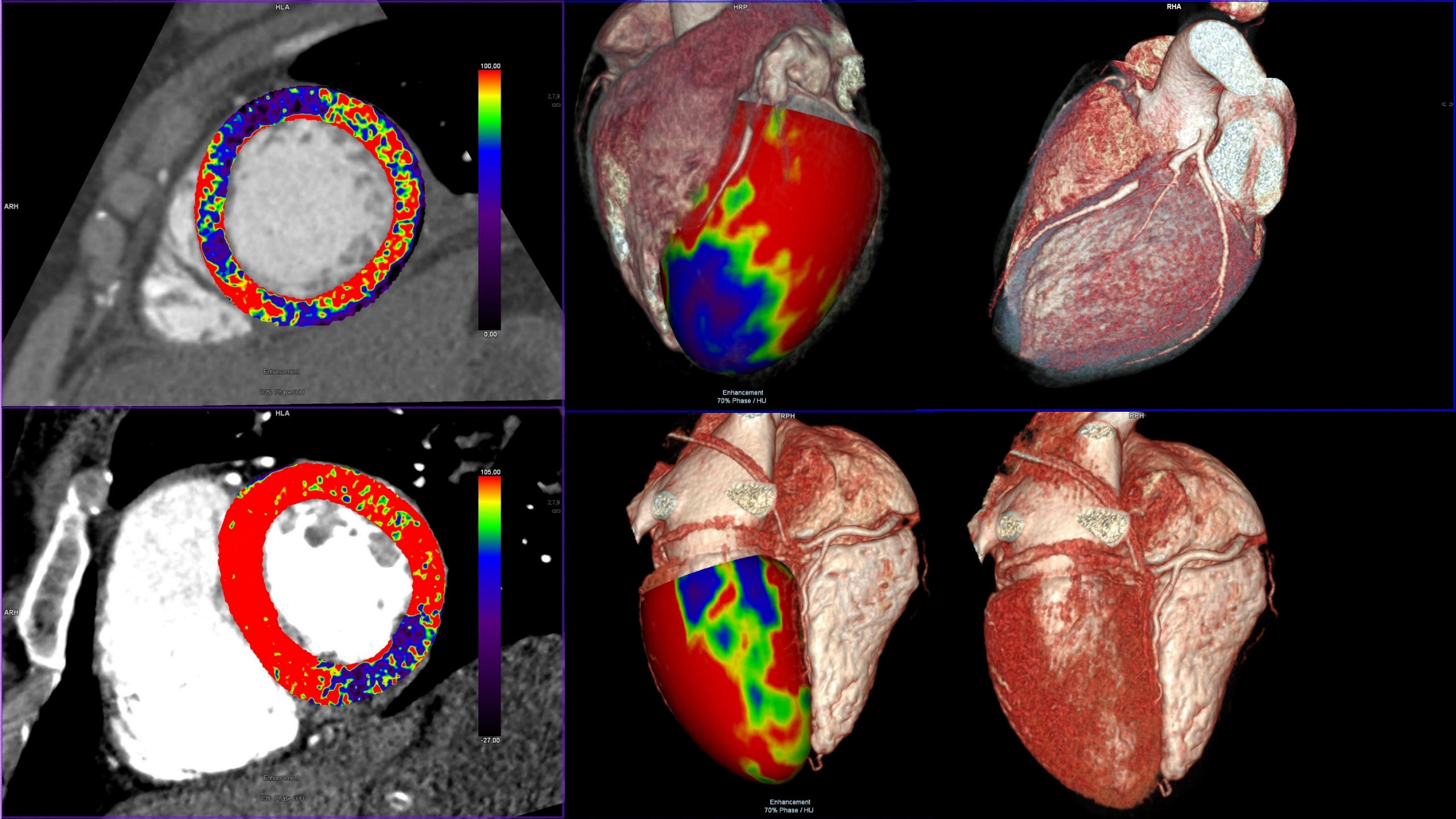
NUTRITIVE TERRITORIES



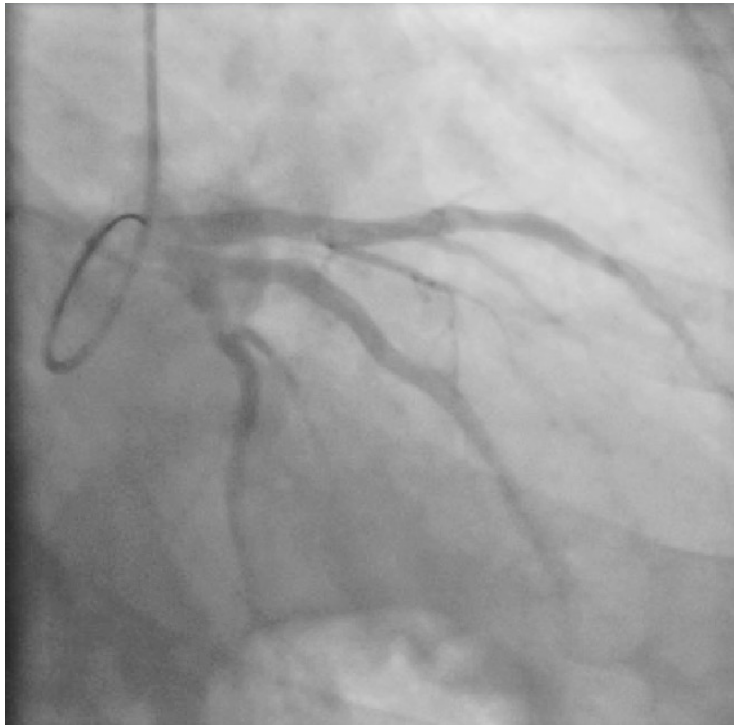
- Basic territories



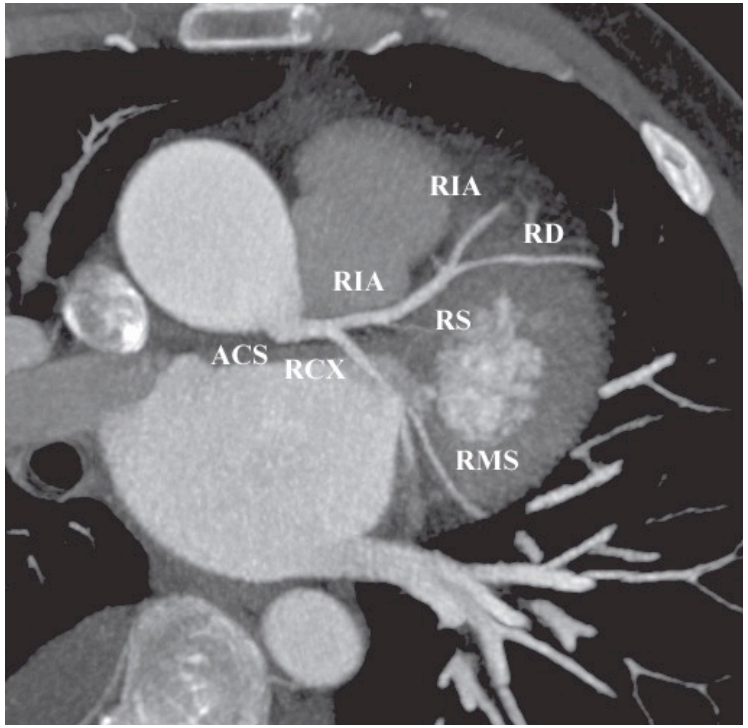
NUTRITIVE TERRITORIES

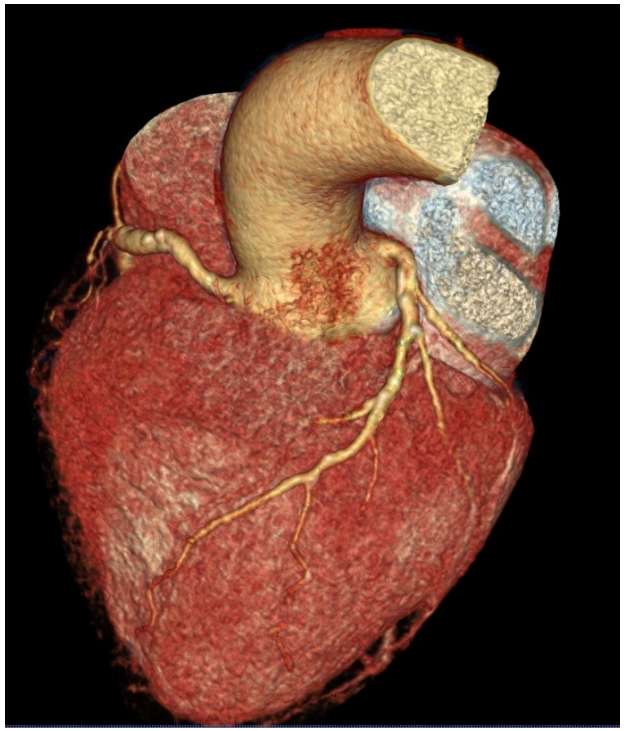

HLA
100,00
0,00
ARH
Enhancement
70% Phase / HU
HRP
Enhancement
70% Phase / HU
RHA
HLA
105,00
-27,00
ARH
Enhancement
70% Phase / HU
RPH
Enhancement
70% Phase / HU
RPH

- Catheter based angiography
  - Standardized projection

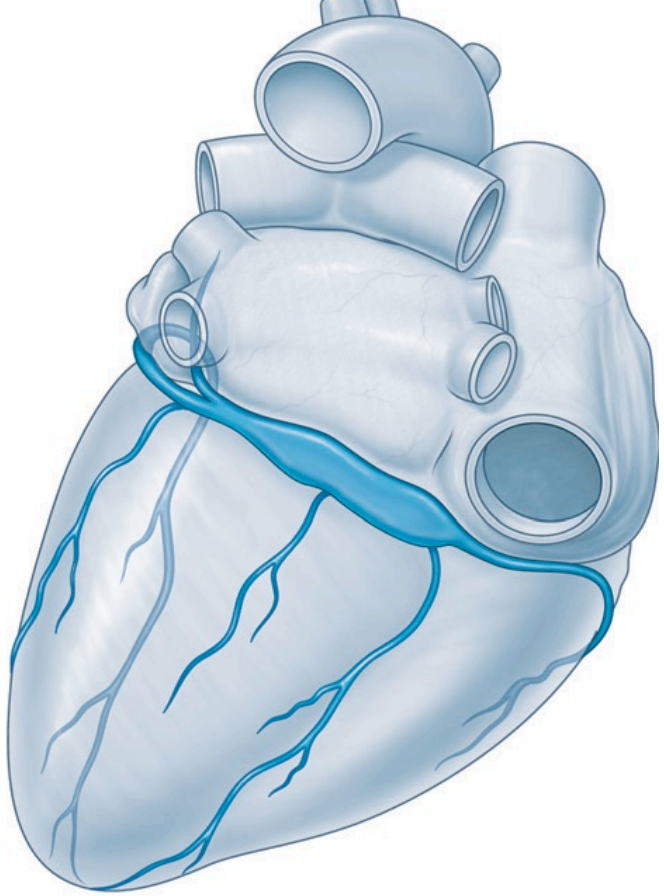


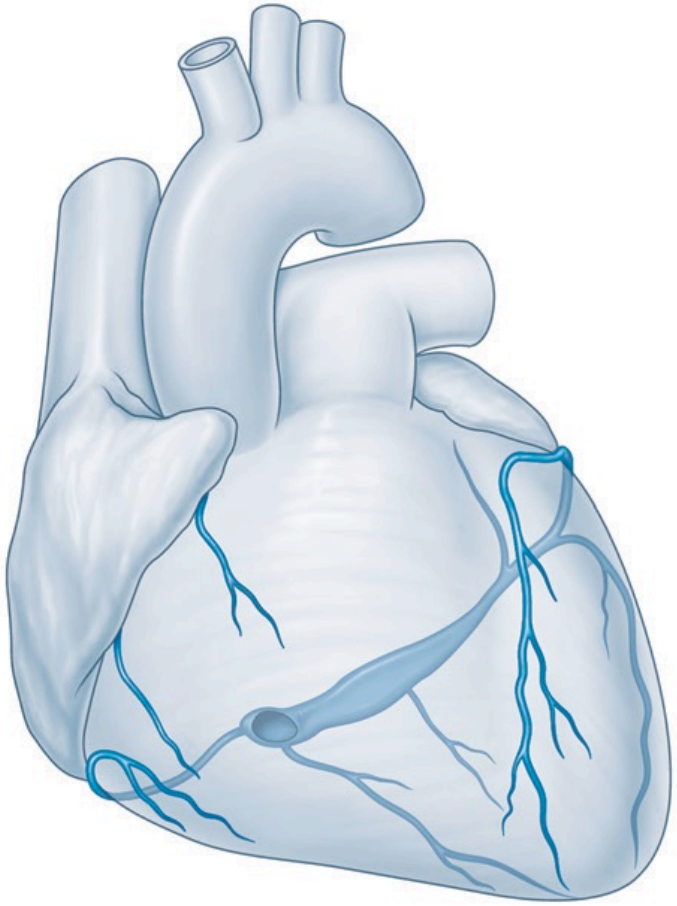
- CT angiography
  - 3D zobrazení





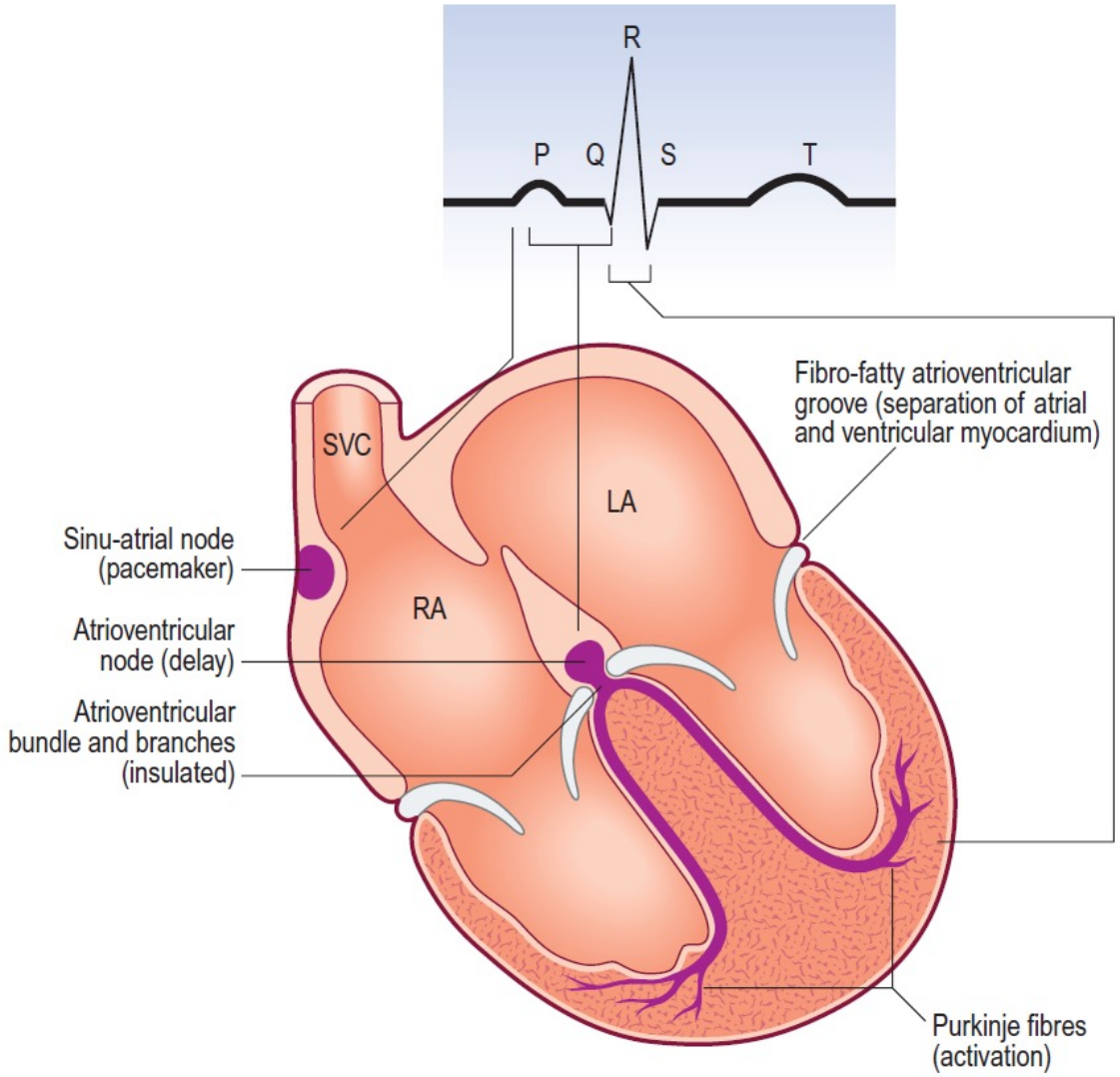
CORONARY IMAGING





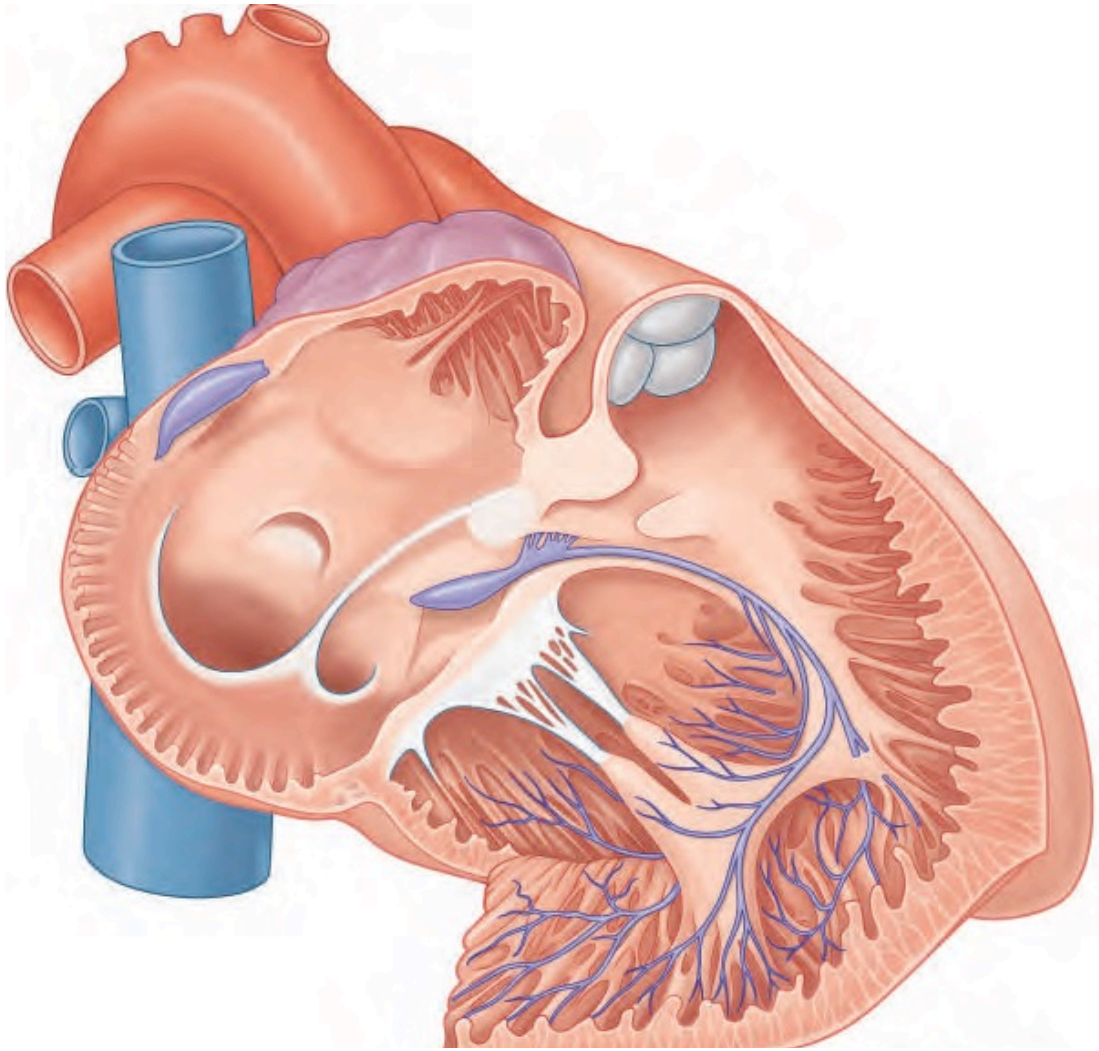
- ***V. interventricularis anterior***
- ***V. cordis magna***
  - *(sulcus interventricularis ant.)*
- **Sinus coronarius**
  - **sulcus coronarius mezi AS/VS)**
  - *Opens to right antrium*
- ***V. cordis media***
  - *(sulcus interventricularis post.)*
- ***V. cordis parva***
  - *(sulcus coronarius mezi AD/VD)*
- **Vv. anteriores ventriculi dextri**
  - *Directly to right ventricle*
- **Vv. minimae (thebesii)**
  - *Into the neares cavity*

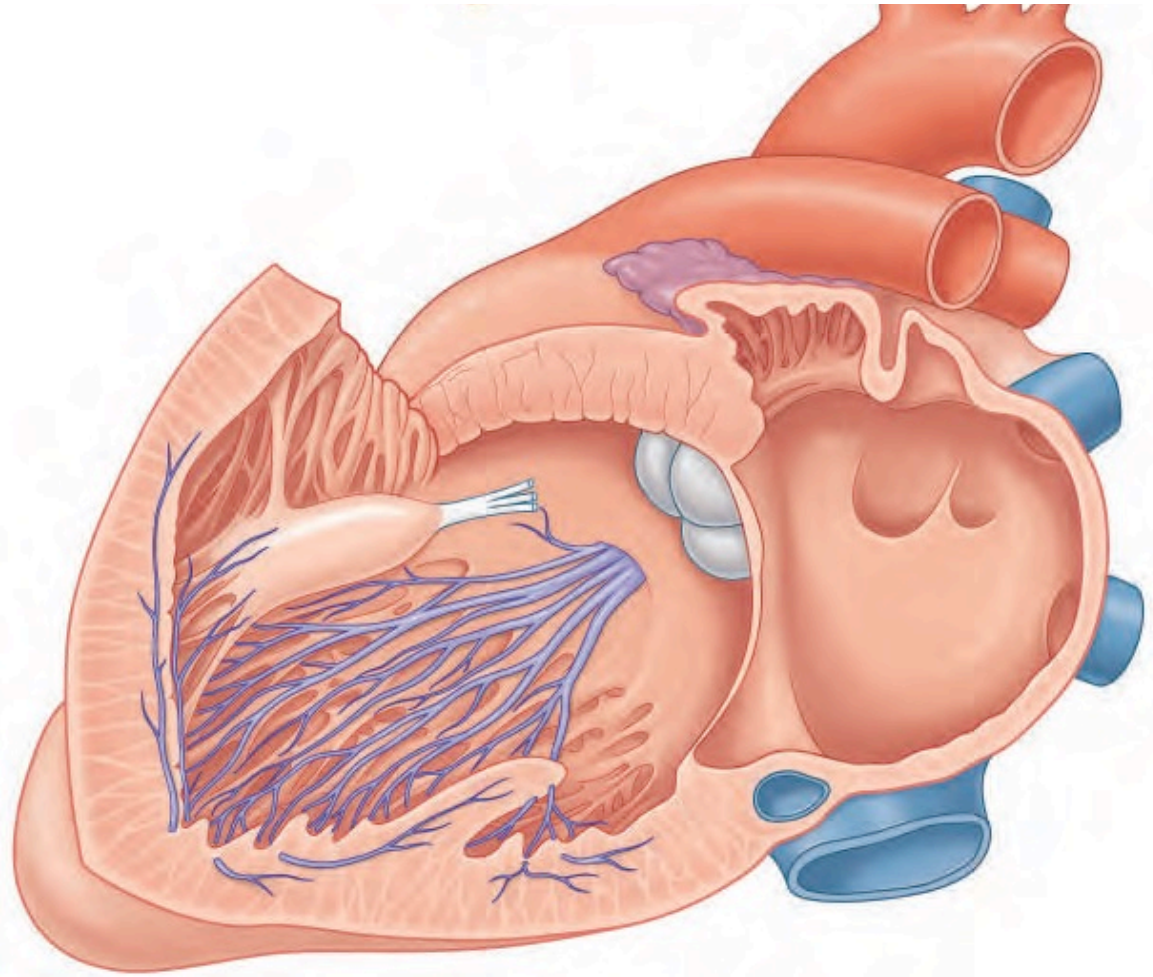
VENAE CORDIS



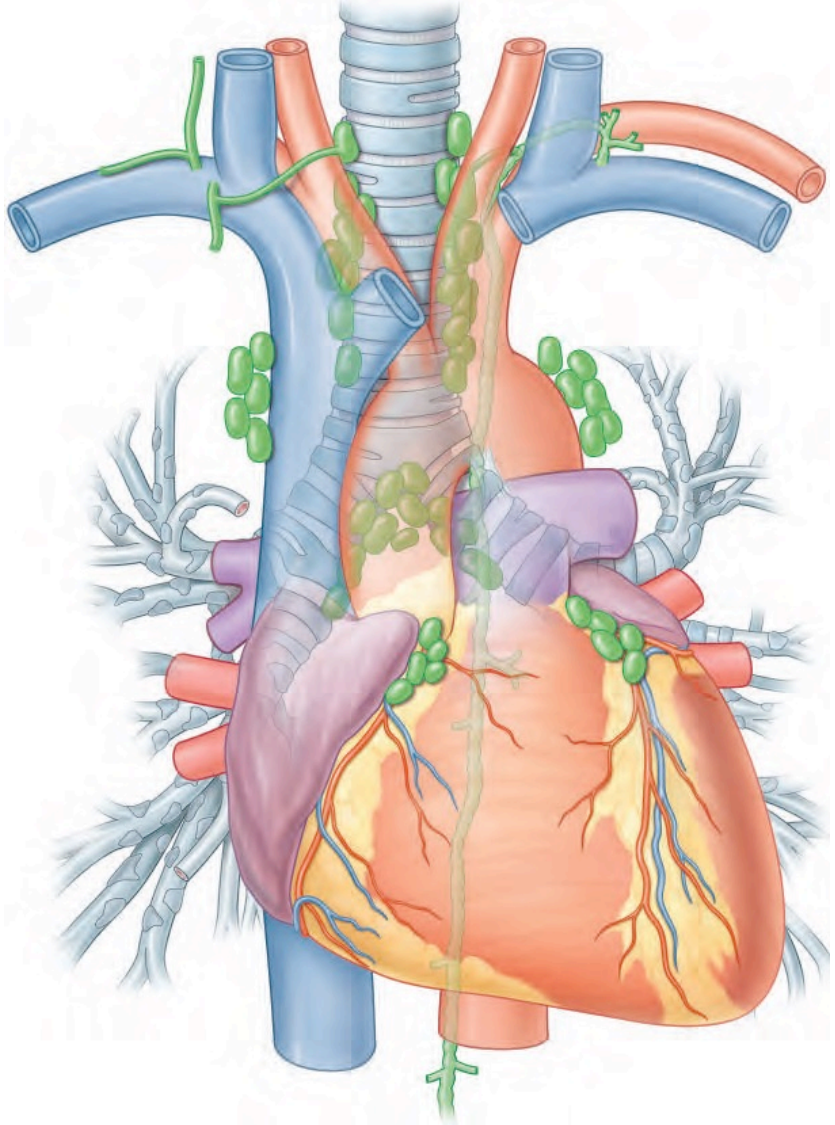
- **Nodus sinoatrialis** ***(crista terminalis upper margin)***
  - **Pacemaker 60 - 80/min**
- **Nodus atrioventricularis (ústí sinus coron.)**
  - **Secondary pacemaker - 40 - 50/min**
- **Fasciculus atrioventricularis - follows AVN**
  - **Fasciculus dexter**
  - **Fasciculus sinister**
- **Subendocardial plexus - Purkynje fibers**
- **One-way conduction**
- **Isulated by connective tissue**
  - **Isolation from other myocardium**
- **Axtitation from apex and papillary musclest to outflow part**

CONDUCTION SYSTEM



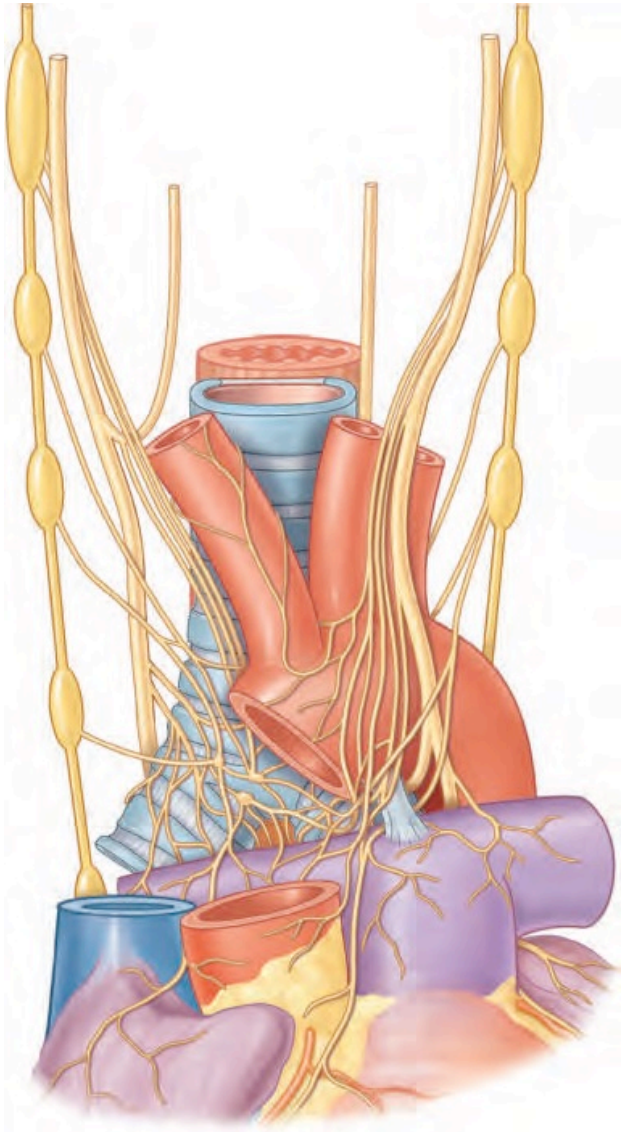


CONDUCTION SYSTEM



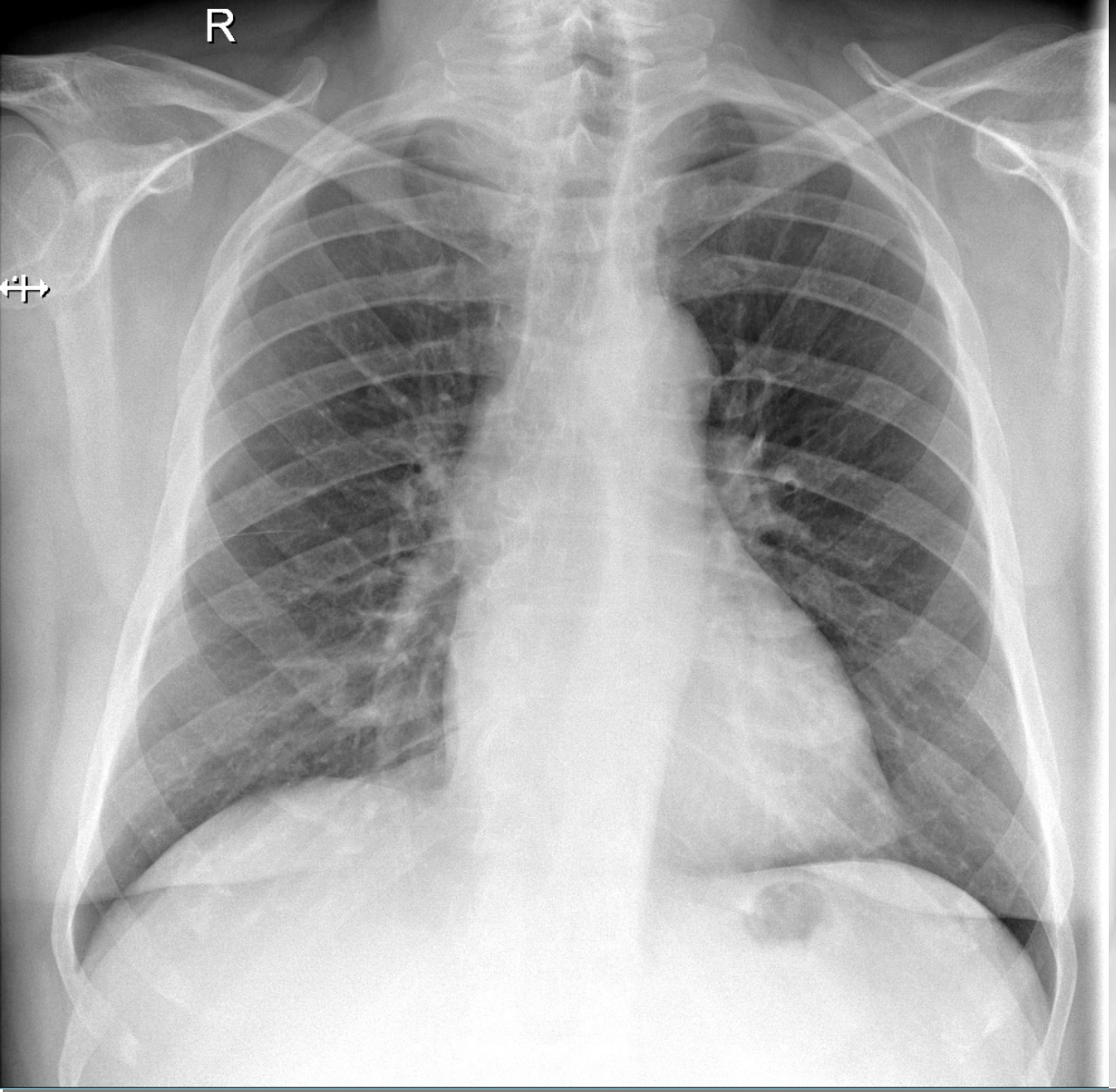
- Lyphatic vssels accopanies blood-vessels
- Flow tovwards
  - mediastinum- tractus bronchomediastinalis
  - Tracheal bifurcatio
- Territorial lymph nodes
- Nodi mediastinales anteriores
- Nodi tracheobronchiales superiores
- Nodi paratracheales
- Nodi mediastinales posteriores
- Nodi diaphragmatis superiores dx. et. sin.

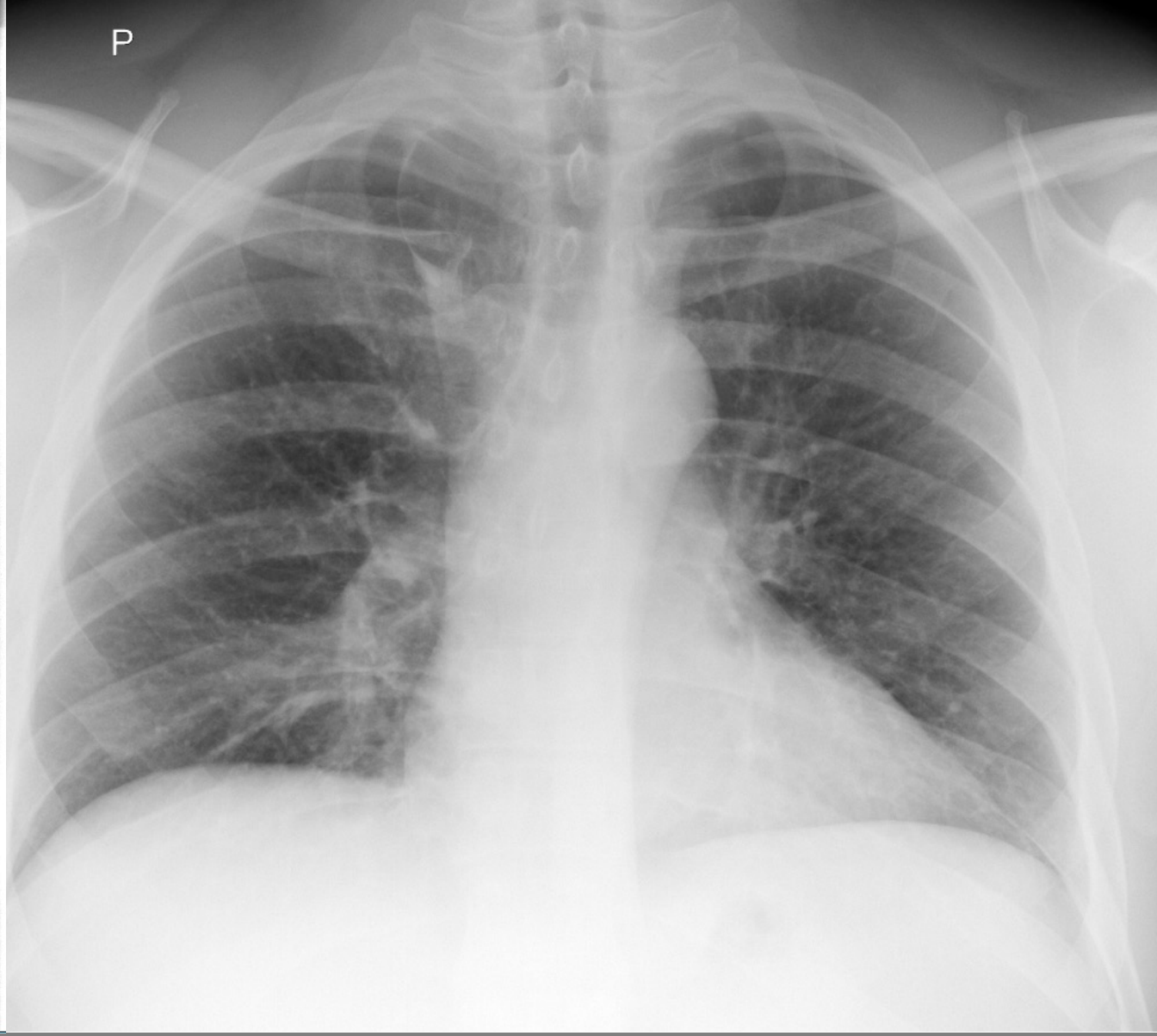
VASA LYMPHATICA CORDIS



- **Parasympaticus**
  - Lowering fequency, decreasing power
  - Contraction of coronary arteries
  - N. vagus - ramus cardiacus sup., medius (n. recurrens), inf.
- **Sympaticus**
  - Increasing frequency, increasing power
  - Dilatation of coronaries – circulary musculature
- N. cardiacus superior - ganglion cervicale superius
- N. cardiacus medius - ganglion cervicale medium
- N. cardiacus inferior - ganglion cervicothoracicum (stellatum)
- Afferent pain sensation - dermatoms Th1-4
  - Ichemic pain
- **Cardiac plexus**
  - Pars superficialis, pars profunda

NERVI CORDIS

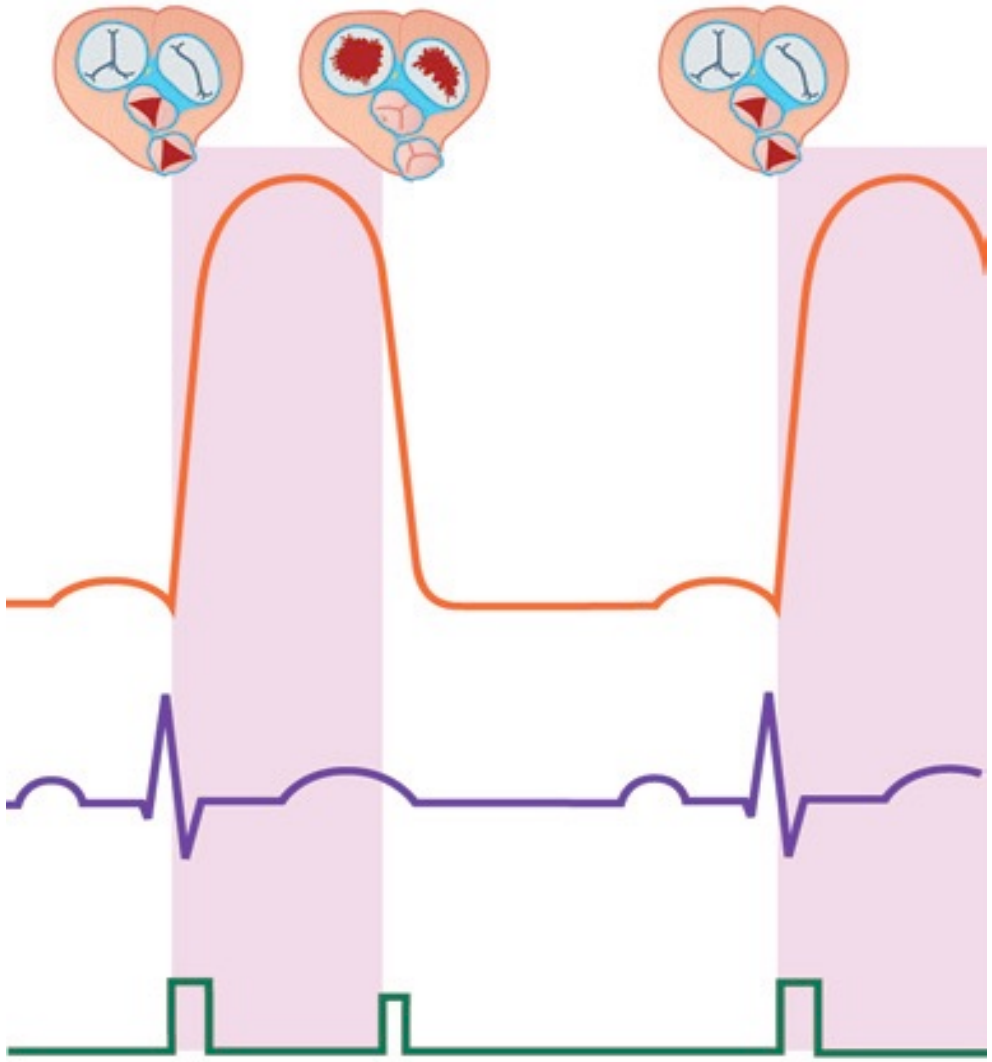




HEART SHADDOW ON X-RAY

- Testuto points
- A - 3. intercostal space right 1 cm from sternum
  - VALVA AORTAE
- B - 5. intercostal space right by sternum
  - VALVA TRICUSPIDALIS
- C - 5. intercostal space left 8 cm from sternum
  - VALVA BICUPIDALIS (MITRALIS)
- D - 2. intercostal left 2 cm from sterna
  - VALVA TRUNCI PULMONALIS

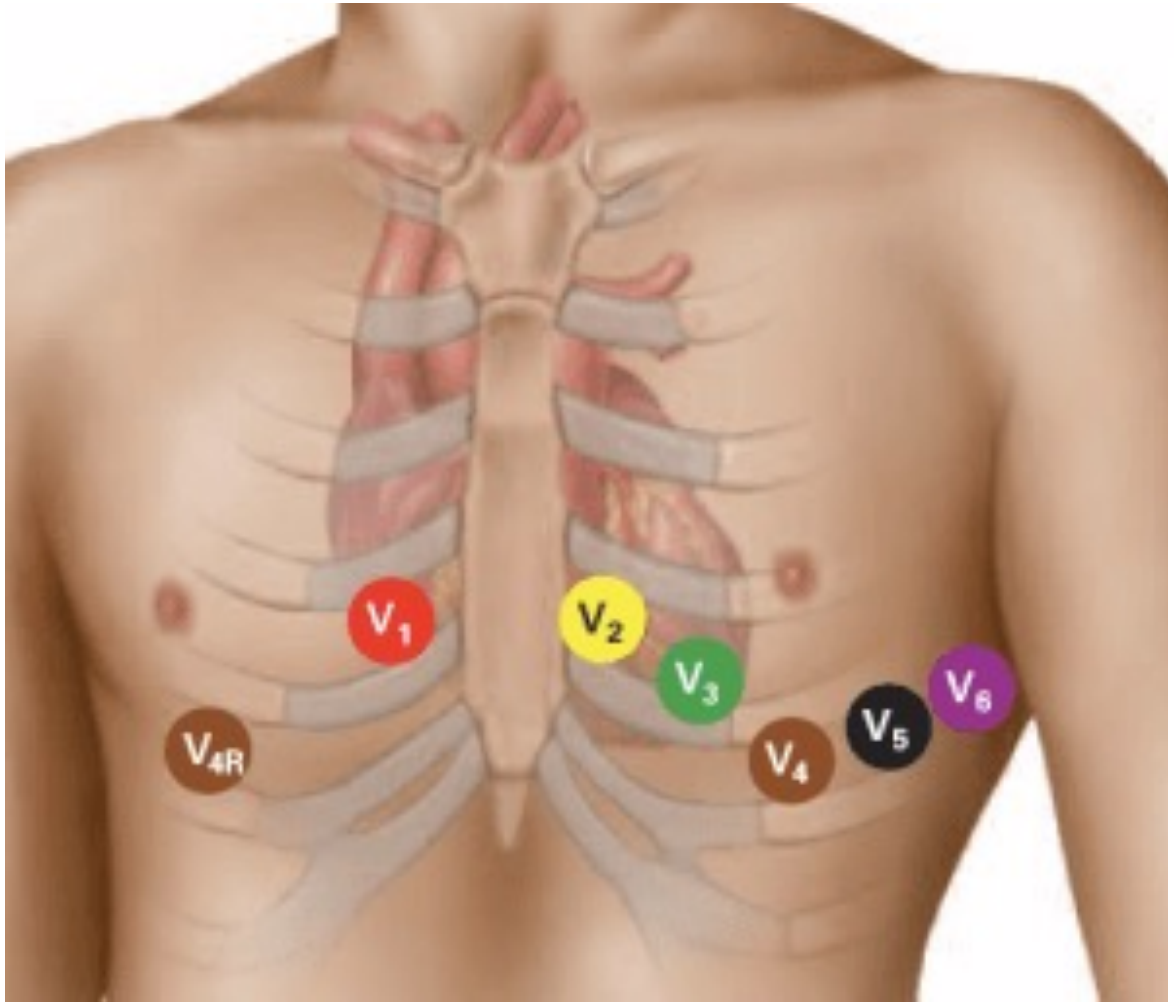
AUSCULTATION POINTS

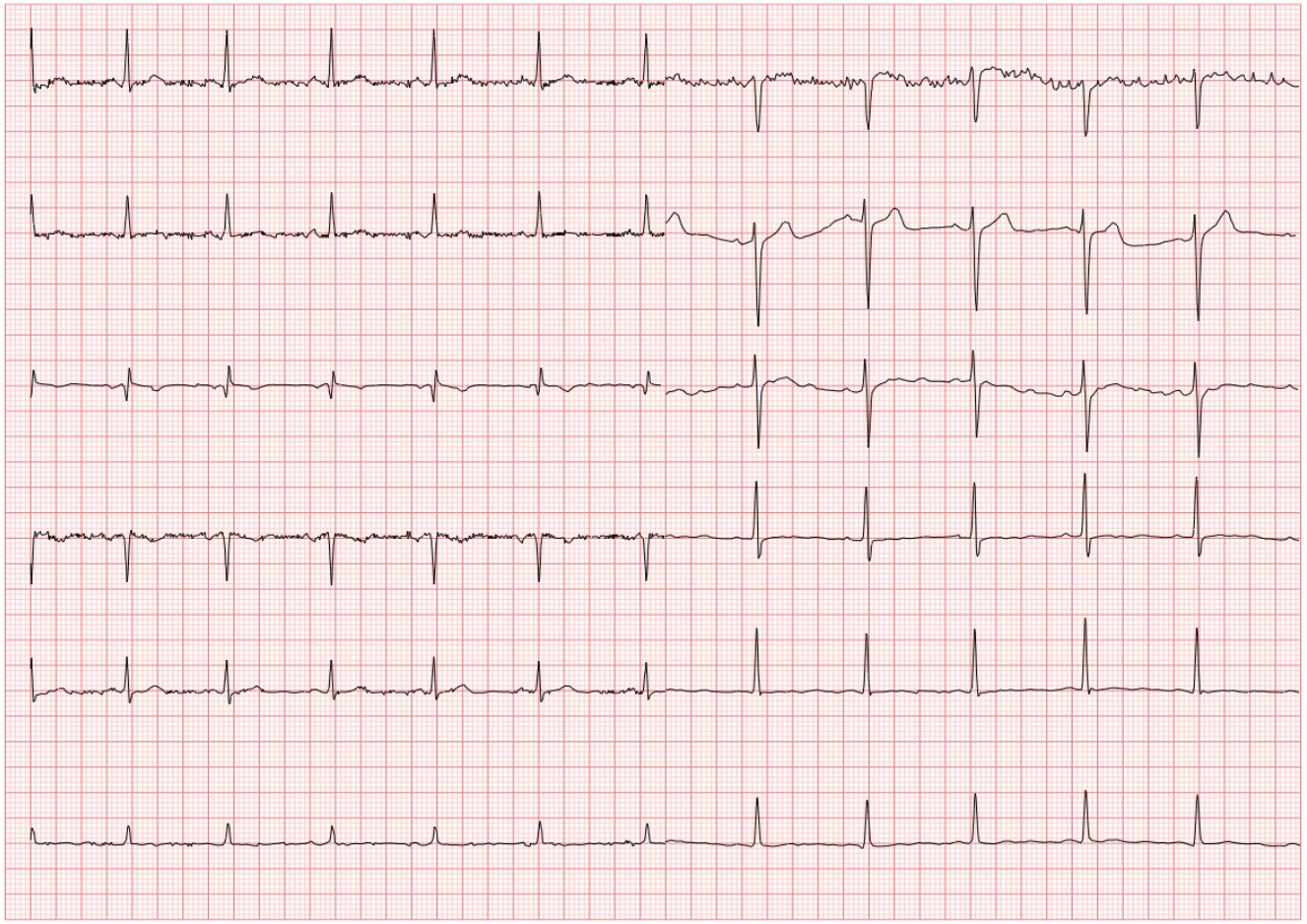


- First heart sound
- Closing mitral and tricuspidal valves
- + contraction of muscle
- Darker and longerDUB
- Second heart sound
- Closing aortal and pulmonal valves
- + arterial resonance
- Clear and shorter LUB
- murmur
- Insuficience, stenosis

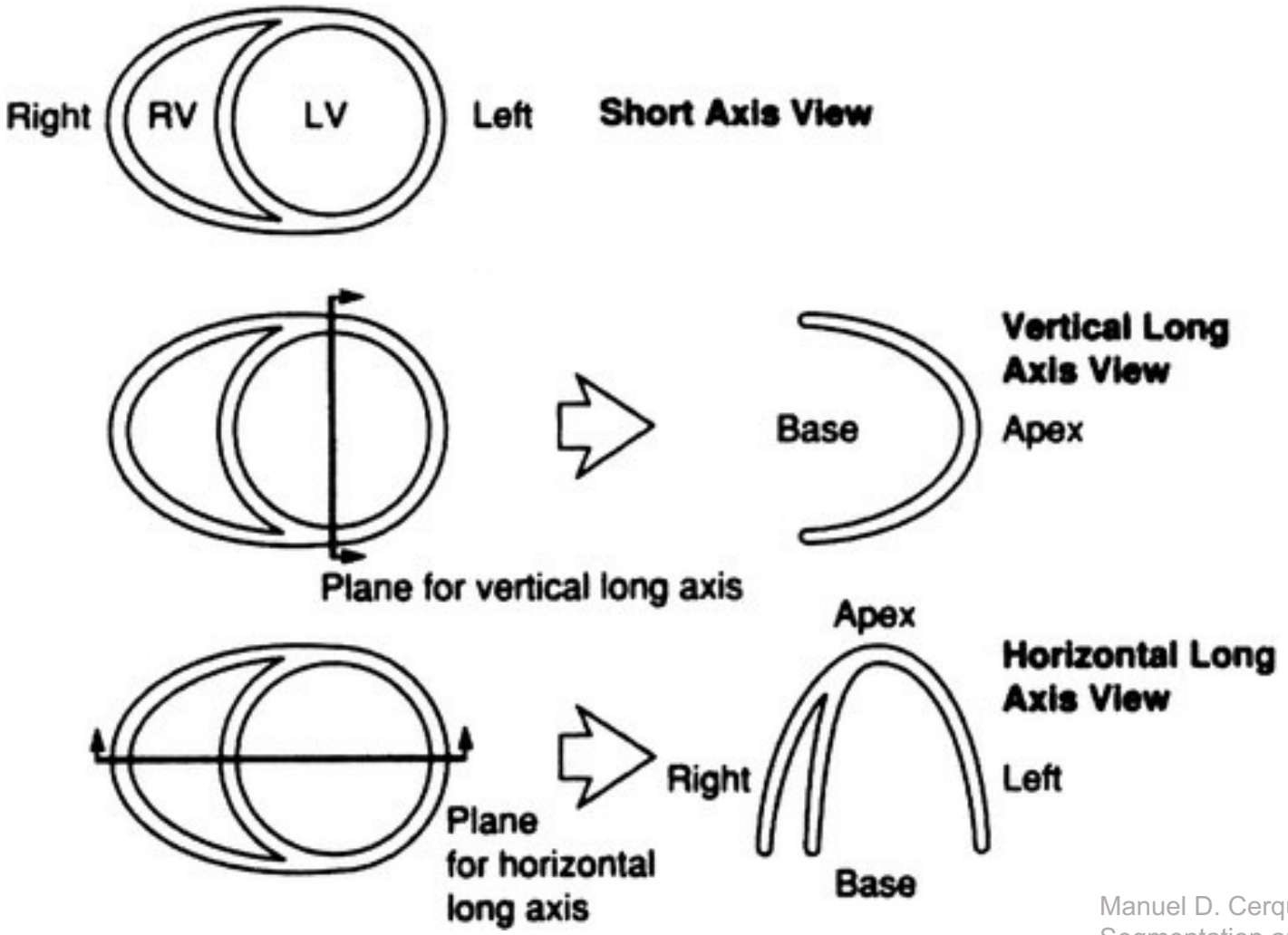
HEART SOUNDS

- 12 lead EKG





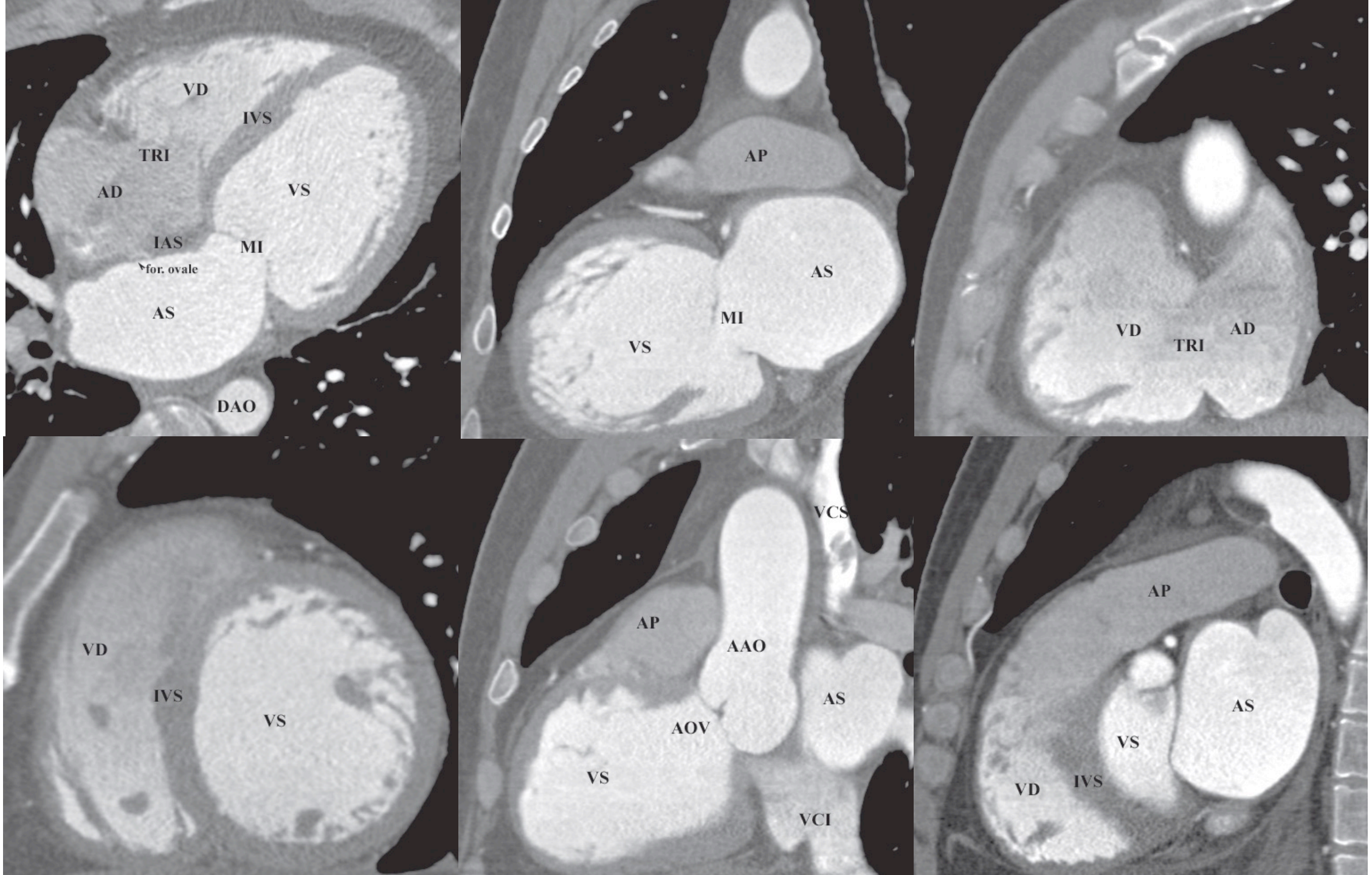
EKG LEADS

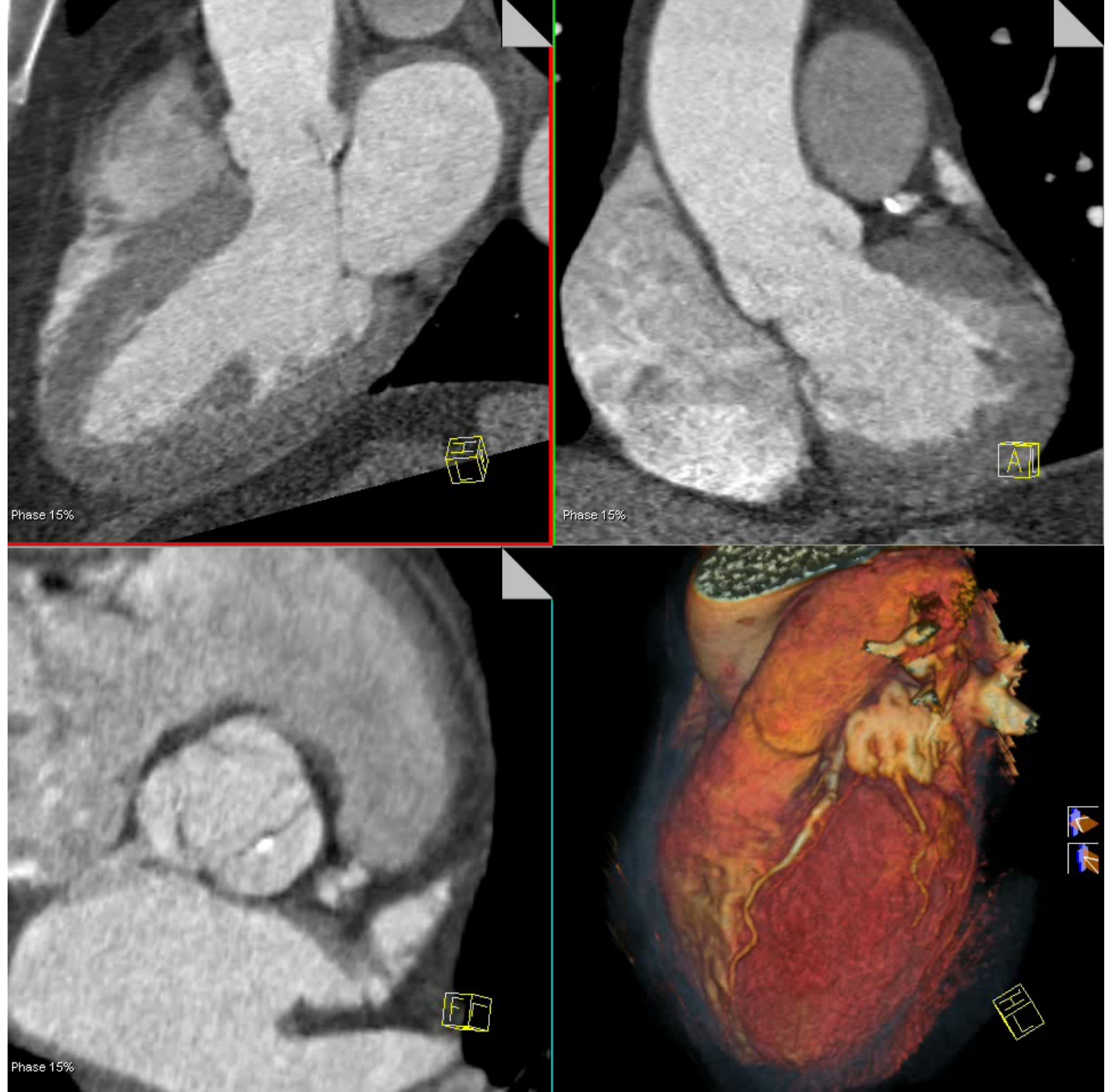


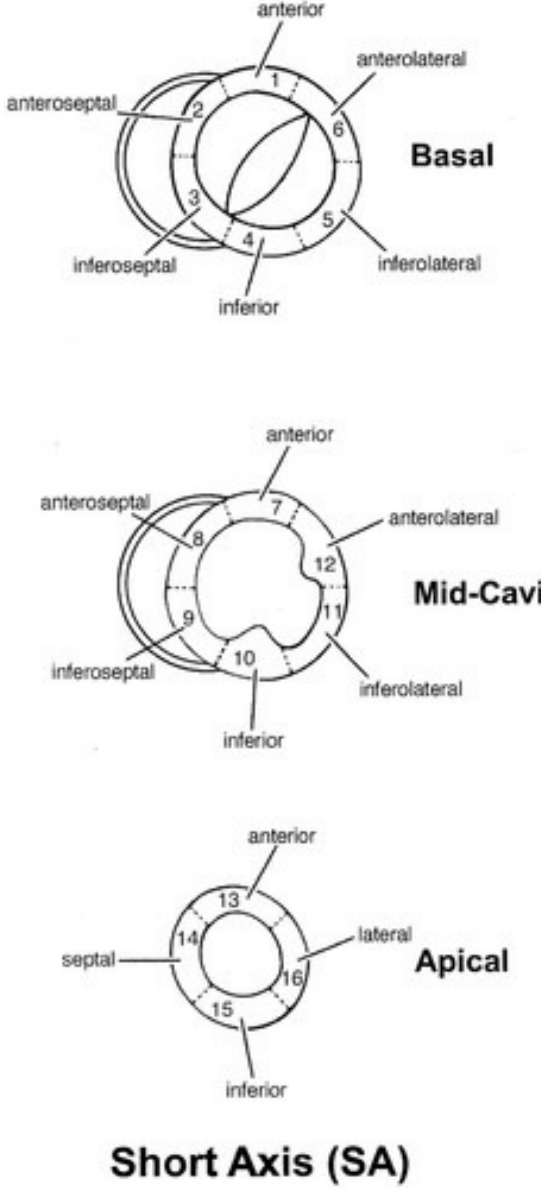
- echocardiography
- CT
- MRI
- Short axis – two-chamber
- Vertical long axis - two-chamber
- Horizontal long axis - four-chamber
- Double-outlet
- Left ventricle outlet
- right ventricle outlet

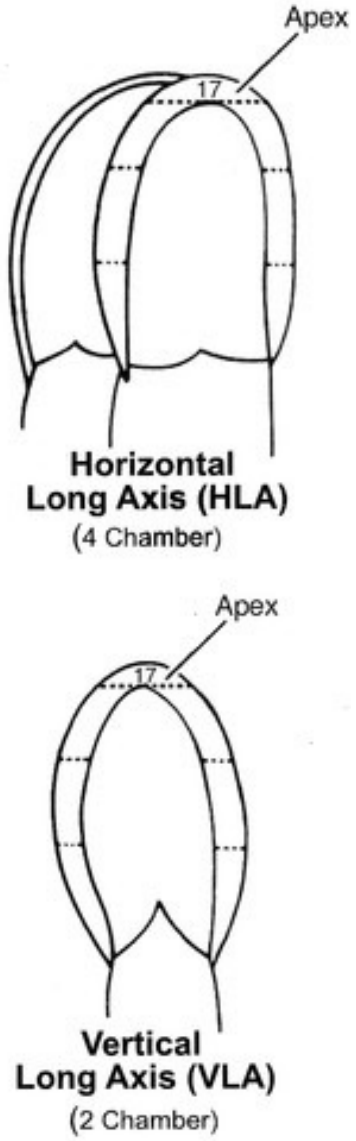
Manuel D. Cerqueira. Circulation. Standardized Myocardial Segmentation and Nomenclature for Tomographic Imaging of the Heart, Volume: 105, Issue: 4, Pages: 539-542, DOI: (10.1161/hc0402.102975)

IMAGING PLANES OF THE HEART

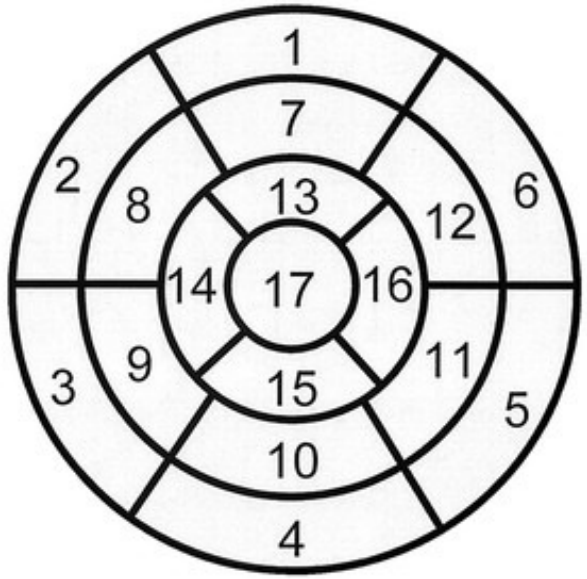

VD
IVS
TRI
AD
VS
IAS
MI
for. ovale
AS
DAO
AP
AS
MI
VS
VD
TRI
AD
VD
IVS
VS
VCS
AP
AAO
AS
AOV
VS
VCI
AP
AS
VS
VD
IVS


Phase 15%
Phase 15%
Phase 15%





Left Ventricular Segmentation



1. basal anterior
2. basal anteroseptal
3. basal inferoseptal
4. basal inferior
5. basal inferolateral
6. basal anterolateral
7. mid anterior
8. mid anteroseptal
9. mid inferoseptal
10. mid inferior
11. mid inferolateral
12. mid anterolateral
13. apical anterior
14. apical septal
15. apical inferior
16. apical lateral
17. apex

Manuel D. Cerqueira. Circulation. Standardized Myocardial Segmentation and Nomenclature for Tomographic Imaging of the Heart, Volume: 105, Issue: 4, Pages: 539-542, DOI: (10.1161/hc0402.102975)

17-SEGMENTS-MODEL AHA

THORAX 3

sources