THE HEART

The localization of the heart

- **Above the diaphragm, in the inferior middle mediastinum**
- **2/3 left, 1/3 right**

The external shape of the heart

- **Unpaired, hollow, muscular organ of solid consistency, reddish brown colour**
- **4,5% of the body weight (fist-sized)**
- **Is of a cone shape**
- **The longitudinal axis of the heart (connector of vena cava superior and the apex)**

- **basis - basis cordis - directs rightwards, up and backwards**
- **apex- apex cordis – directs for-, left- and downwards**
- **Facies anterior (sternocostalis)**
- **Facies posterior (diaphragmatica)**
- **Margo dexter (acutus)**
- **Margo sinister (obtusus)**

The chambers of the heart

- Atrium dextrum
- Atrium sinistrum
- Ventriculus dexter
- Ventriculus sinister

Septum cordis: divides the heart chamber into the right and left part

Atrias: at ***basis cordis***

- The superficial border between the atrias and the ventricles is formed by transversally oriented groove – ***sulcus coronarius***
- ***auricula dextra et auricula sinistra***
- ***septum interatriale***

Ventricles : při apex cordis

- The border is *sulcus interventricularis anterior* et *posterior*, *corresponding to the localization of septum interventriculare*
- Right ventricle: *truncus pulmonalis*
- Left ventricle: *aorta*

aorta

truncus pulmonalis

Atrium dextrum – cube with six walls

outcome: *vena cava superior et vena cava inferior*

***sinus coronarius* (the venous sinus of the heart)**

1) **Superior wall - *ostium venae cavae superioris***
2) **Inferior wall - *ostium venae cavae inferioris*, *ostium sinus coronarii* and *ostia venae cordis anteriores***

ostium venae cavae superioris

ostium sinus coronarii

ostium venae cavae inferioris

4) Medial wall - *septum interatriale* s *fossa ovalis* with slightly raised edge *(limbus fossae ovalis)*

5) On the lateral wall - *crista terminalis*, which separates the posterior part – *sinus venosus* *from the anterior one*

limbus fossae ovalis

fossa ovalis

crista terminalis

3) Posterior wall – between openings of both venae cavae it vaults dorsally as *torus intervenosus*

6) Anterior wall corresponds to atrioventricular septum with *ostium atrioventriculare dextrum (valva tricuspidalis), right from the opening theresis auricula dextra*

torus intervenosus

ostium atrioventriculare dextrum

Atrium sinistrum - *venae pulmonales* (4 pulmonary veins)

Septal wall: ***fossa ovalis*** ***lined from behind with fold (falx septi)***, **dorsocranially venae pulmonales**

Anterior wall: ***ostium atrioventriculare sinistrum*** **(*valva bicuspidalis*),** ***auricula sinistra***

- **Smooth wall, has originated from pulmonary veins**
- **auricle (*auricula*) original atrium (plicated)**

Ventriculus dexter

Triangular pyramid shape:
Widen upper part consists:
ostium atrioventriculare dextrum
ostium trunci pulmonalis

Ostium atrioventriculare dextrum
(valva tricuspidalis)
cuspis anterior, posterior, septalis
Musculi papillares

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ostium trunci pulmonalis

ostium aortae

ostium atrioventriculare sinistrum

ostium atrioventriculare dextrum

Ostium trunci pulmonalis

- ***valva trunci pulmonalis***
- ***valvula semilunaris anterior, dextra et sinistra***
- **Folds form together with the wall of *truncus pulmonalis* three semilunar pockets *(sinus trunci pulmonalis)***

The medial wall is formed by *septum interventriculare*

Cavity of the right ventricle we can divide into inflow and outflow parts.

Inflow part *(pars trabecularis)* with *trabeculae carneae*, from *ostium atrioventriculare dextrum* till apex of the heart.

Outflow part *(pars glabra)* smooth walls from apex upwards and forward, towards to *truncus pulmonalis*, border between both parts presents transversely oriented muscular crest *(crista supraventricularis)*.

Inflow part

Outflow part

Ventriculus sinister

- **Cone shape**
- ***ostium atrioventriculare sinistrum: valva bicuspidalis (mitralis), cuspis anterior a posterior***
- ***ostium aortae***
- ***musculus papillaris anterior et posterior (papillary muscles)***

Ostium aortae

- ***valva aortae***
- ***valvula semilunaris dextra, sinistra et posterior*** **form three semilunar folds *(sinus aortae)*, on the surface of the artery vault as *bulbus aortae***
- **from *sinus aortae* arise coronary arteries**

The cavity of the left ventricle:

- **Inflow part contains *trabeculae carneae* and lies between *ostium atrioventriculare sinistrum* and the apex**
- **Outflow part directs from apex to aorta and has a smooth wall**

Inflow part

Outflow part

Valves of the heart– derivatives of endocardium

Cuspidal valves(*valvae atrioventriculares*)

- ***valva tricuspidalis* (right)**
- ***valva bicuspidalis* (left)**

Tops of particular cusps head to hollow of the ventricle, the cusps are connected to *musculi papillares* through heart strings *(chordae tendineae)*

Semilunar valves (*valvae semilunares*)

- ***valva trunci pulmonalis***
- ***valva aortae***

The structure of the heart

1. Endocardium
2. Myocardium
   A. working
   B. conductive
3. Pericardium

1. Endocardium

- Thin, smooth and glossy fibrous membrane
- Covers all cardiac chambers and surface of all the valves

2. Myocardium

- Main component of the cardiac wall

  working myocardium (contractions of cardiac compartements)

  conductive myocardium (conductive systém of heart)

A) Working myocardium: (muscles of atria and muscles of ventricles are separated)

a) Muscle of atria– 2 layers, spf. layer – common for both atria, deep layer- separate

b) Muscle of ventricles (thicker)

3 layers:

- **Superficial layer:** common, arranged into bands which create whirl *(vortex cordis)*
- **middle layer** is separate, band oriented cicularly
- **deep layer** organized in reticular arrangement, forms underlay of mm. papillares and trabecular system

muscles of atria and ventricles are separated by cardiac skeleton !

The fibrous skeleton of the heart

- **Consists of fibrous connective tissue (form fibrous arches, anuli fibrosi), on borderline between atrias and ventricles**
- ***anulus fibrosus dexter***
- ***anulus fibrosus sinister***
- ***anulus aorticus***
- ***anulus trunci pulmonalis***

Trigonum fibrosum dextrum et sinistrum

B) Conductive myocardium (conductive system of the heart)

- **Consists of an unique type of myocardium, its cells generate impulses which are stimuli for the muscular contractions**

It consists of:

***a) Nodus sinuatrialis* in the right atrium– generates impulses (70/min)**

***b) Nodus atrioventricularis* in the right ventricle under the endocardium of septum**

***c) Fasciculus atrioventricularis* passes through aperture in *trigonum fibrosum dextrum* into interventricular *septum* and divides into two branches**

***d) Crus dextrum et crus sinistrum* – head toward myocardium of right and left ventricle**

e) Purkyně (Purkinje) fibres create large subendocardial net

3. The Perikardium

The heart is stored in a firm fibrous sac, it has two layers:

external layer– *pericardium fibrosum*

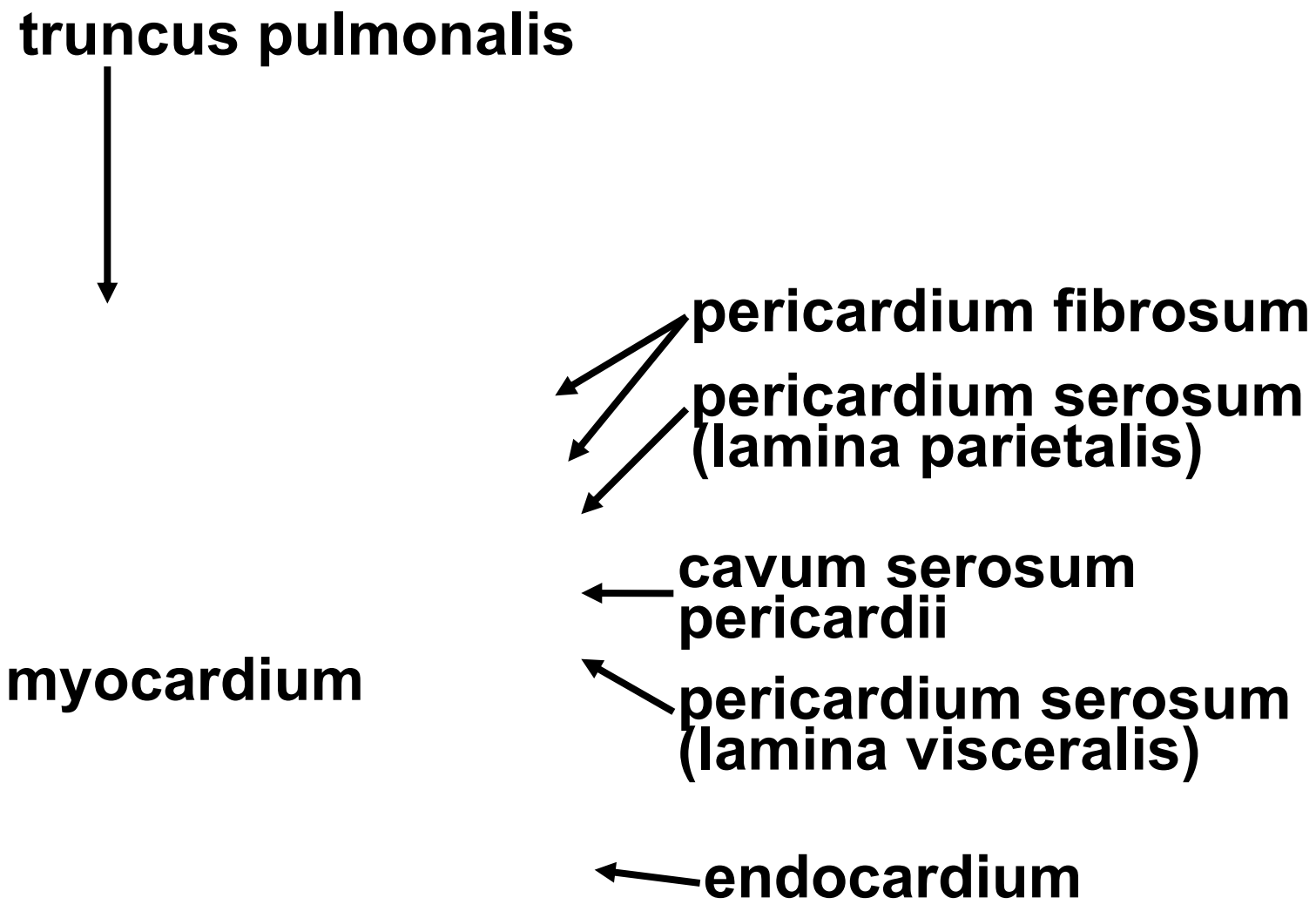
internal layer– *pericardium serosum*

1)Pericardium fibrosum

- **base-facies diaphragmatica-basis pericardii**
- **apex- cupula pericardii**

2)Pericardium serosum

- **External sheet *(lamina parietalis)***
- **Internal sheet *(lamina visceralis)* or *epicardium***
- ***cavum serosum pericardii:* cavity between the both sheets**


truncus pulmonalis
pericardium fibrosum
pericardium serosum
(lamina parietalis)
cavum serosum
pericardii
myocardium
pericardium serosum
(lamina visceralis)
endocardium

- **Both sheets pass into each other in two places:**
  porta arteriarum
  porta venarum

sinus transversus pericardii*: between *porta arteriarum* and *porta venarum

sinus obliqus pericardii*: below the transverse arm of *porta venarum

The cardiac arteries (Arteriae coronariae cordis)

The heart is supported by two arteries (subepicardially):

arteria coronaria cordis sinistra

arteria coronaria cordis dextra

Arteria coronaria cordis sinistra

a) ramus interventricularis anterior

b) ramus circumflexus

- Supports of wall of left ventricle (including its papillary muscles), anterior part of wall of right ventricle (including *musculus papillaris anterior*) and anterior part of interventricular septum

Arteria coronaria cordis dextra

a) ramus interventricularis posterior

- **Supports majority of wall of right atrium and ventricle (including its papillary muscles), part of posterior wall of left ventricle (including *musculus papillaris posterior*) and posterior part of interventricular septum**

A.c.c. dextra

A.c.c. sinistra

anterior

posterior

Venae cordis

1) *sinus coronarius cordis* (60% of the blood), confluence of:

a) *vena cordis magna*

b) *vena cordis media*

c) *vena cordis parva*

2) *venae cordis anteriores* – 2 till 4 veins, which collect blood from anterior wall of right ventricle

3) *venae cordis minimae* – open into cardiac cavities through separate apertures *(foramina venarum minimarum)*

Venae cordis anteriores at minimae (40% of the blood).

The lymphatic vessels of the heart

They form three lymphatic nets in the cardiac wall:

- **subendocardial**
- **myocardial**
- **subepicardial**

There are two lymphatic trunks draining out the lymph from these nets:

1) Truncus lymphaticus cordis dexter – nodus lymphaticus praeaorticus - nodi lymphatici mediastinales anteriores

2) Truncus lymphaticus cordis sinister- nodus lymphaticus retroaorticus - nodi lymphatici tracheobronchiales

The innervation of the heart

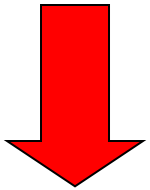
• autonomic nervous sympathetic and parasymphatetic nerve fibres), which influences conduction systém (changes of cardiac rhytm) and wall of coronary vessels

Sympathetic fibres (***truncus sympaticus***): ***nn. cardiaci cervicales (superior, medius, inferior)*** a ***nn. cardiaci thoracici***

symp. fibres - nervi accelerantes *(acceleration of heart activity*+ vasodilatation of the cardiac arteries)

Parasympathetic fibres (**nn.vagi**): ***rami cardiaci superiores, medii, inferiores***

parasymp. fibres - ***nervi retardantes*** *(*deceeleration of herat activity, vasoconstriction of coronary arteries)



Symp. and parasymp. fibres form compound plexuses

1) ***Plexus cardiacus superficialis: ganglion cardiacum***
2) ***Plexus cardiacus profundus***
3) ***Plexus coronarius sinister et dexter***

The projection of the heart

The heart is located in the middle inferior mediastinum. The projection of the heart on the anterior thoracic wall – it is bordered with 4 auscultation points – heart field.

1) **Point A – 2nd intercostal space, circa 1 cm on the right from the sternal margin – Auscultation Point of valva aortae.**
2) **Point B – 5th intercostal space, at left edge of sternum- AP of valva tricuspidalis.**
3) **Point C – 5th intercostal space, left, medially from medioclavicular line – AP of valva bicuspidalis.**
4) **Point D – 2nd intercostal space, left, circa 2 cm from sternal margin - AP of valva trunci pulmonalis.**

A

Valva aortae

D

Valva trunci pulmonalis

B

Valva tricuspidalis

C

Valva bicuspidalis

X – ray (anteroposterior imaging)

- **Images**:
- **Atlas der Anatomie des Menschen/Sobotta.**
- **Putz,R., und Pabst,R. 20. Auflage. München: Urban & Schwarzenberg, 1993**
- **Netter: Interactive Atlas of Human Anatomy.**
- **Naňka, Elišková: Přehled anatomie. Galén, Praha 2009.**
- **Čihák: Anatomie I, II, III.**
- **Drake et al: Gray´s Anatomy for Students. 2010**