Coronary Circulation

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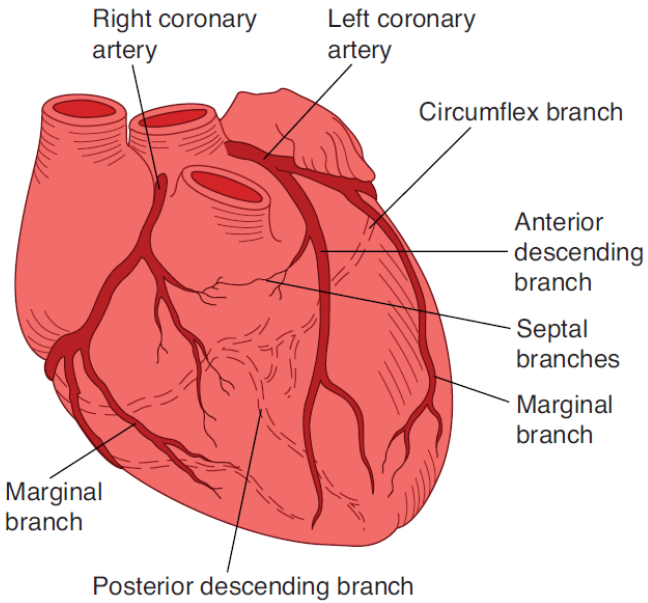
This presentation includes only the most important terms and facts. Its content by itself is not a sufficient source of information required to pass the Physiology exam.

Coronary Circulation

- *a. cor. sinistra*
  85% of the blood flow
  (the frontal part of septum, the conductive system, majority of the left ventricle)
- *a. cor. dextra*
  (the right ventricle, the posterior part of septum and usually also the posterior part of the left ventricle)

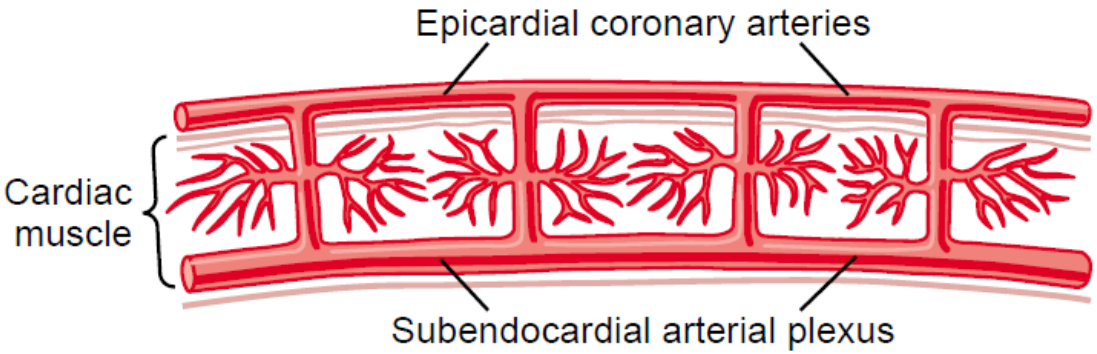
- O_2 diffusion directly from the blood situated in the cardiac cavities
- placing of coronary arteries and capillaries in the cardiac walls



Ganong´s Review od Medical Physiology, 23rd edition

Coronary Circulation

- epicardial coronary arteries supply most of the muscle
- intramuscular arteries (smaller) penetrate the muscle
- plexus of subendocardial arteries



Guyton and Hall. Textbook of Medical Physiology, 11th edition

- During systole, blood flow through the plexus of subendocardial arteries is reduced (compression of intramuscular arteries) – compensated through extra vessels in the plexus (sensitivity to coronary ischemia).

Coronary Circulation

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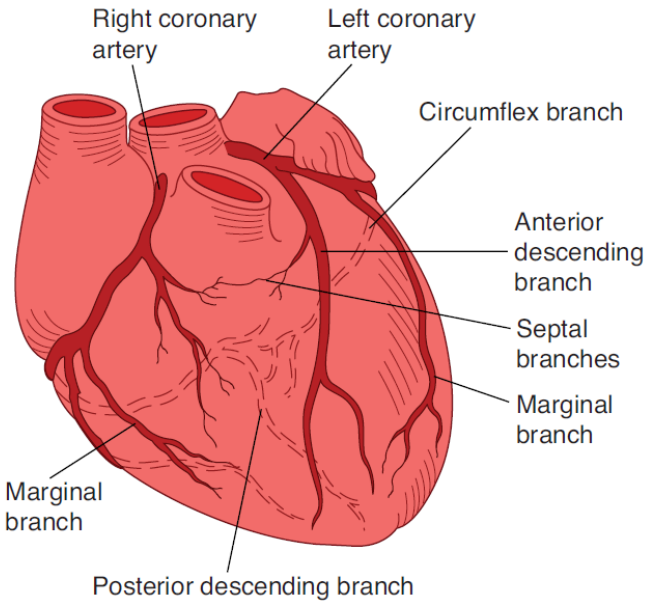
- **coronary angiography**



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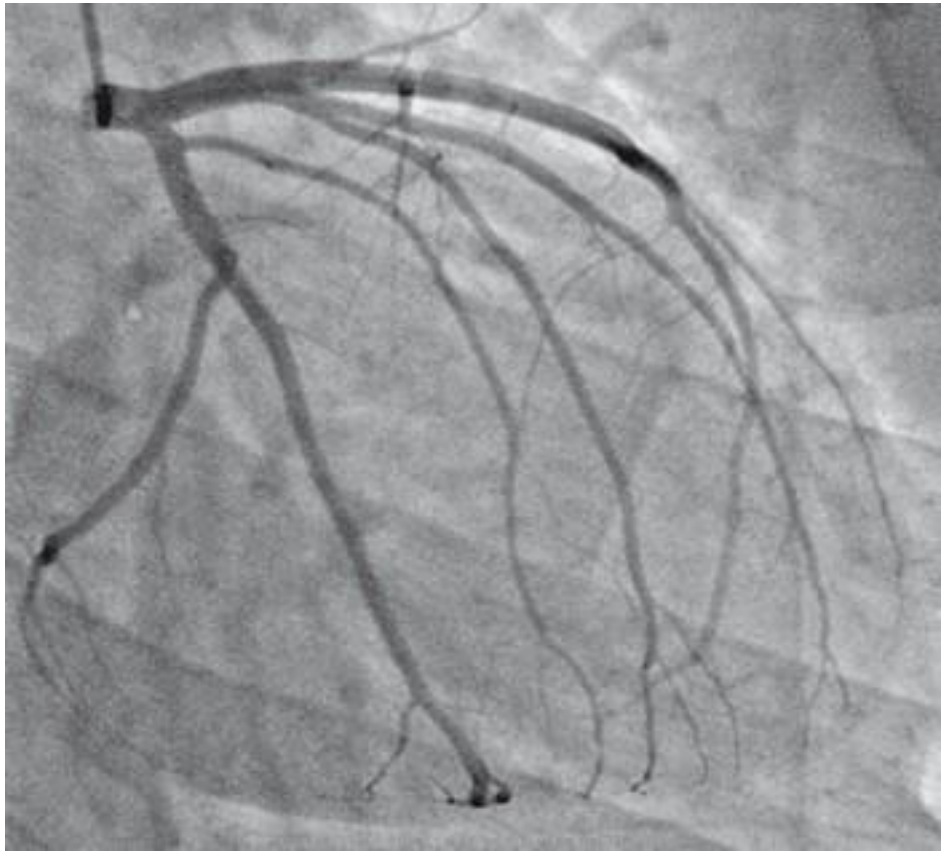
Coronary Circulation



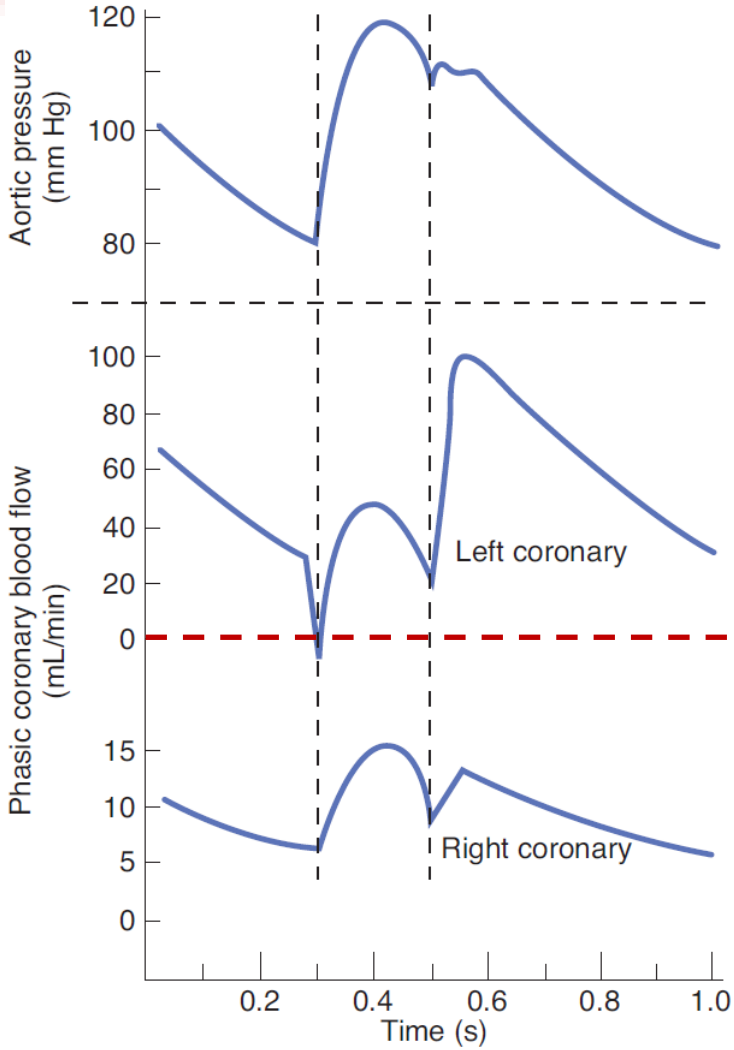
http://pochp.mp.pl/aktualnosci/show.html?id=55102

Coronary Circulation

TABLE 34–4 Pressure in aorta and left and right ventricles (vent) in systole and diastole.

	Pressure (mm Hg) in			Pressure Differential (mm Hg) between Aorta and	
	Aorta	Left Vent	Right Vent	Left Vent	Right Vent
Systole	120	121	25	–1	95
Diastole	80	0	0	80	80

- during the systole, vessels situated intramurally are pressed by the contracting myocardium
- left *vs.* right ventricle
- high heart rate



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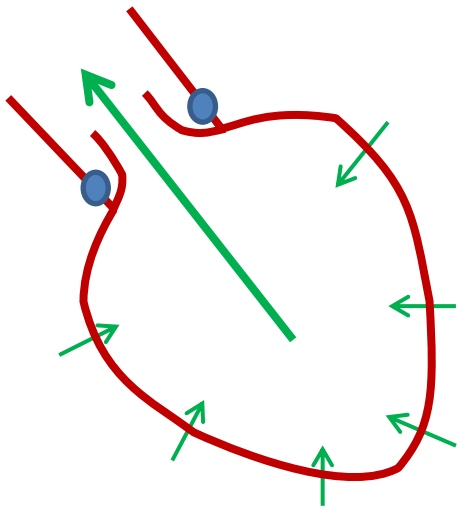
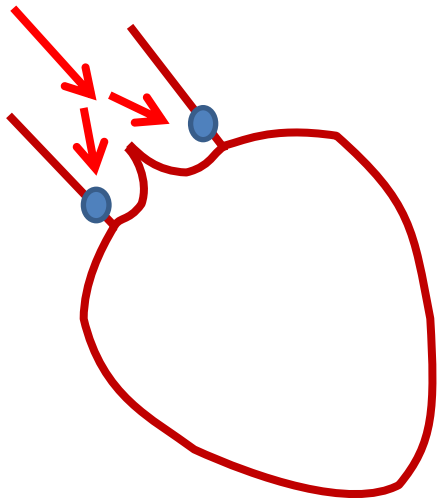
Coronary Circulation

- orificia of the coronary arteries

ejection



isovolumic relaxation



Coronary Circulation

- O_2 extraction is almost maximal already at rest, capillaries are open

↓

- The only possibility how to increase O_2 supply (for example during exercise) is the coronary vasodilation!

Coronary Circulation

Control of coronary blood flow

1) reduction/interruption of the blood flow or increased demands (exercise, increased blood pressure)

↓

hyperaemia (reactive or active) based on the metabolic vasodilation

mediators: $\downarrow pO_2$, $\uparrow pCO_2$, $\downarrow pH$, $\uparrow [K^+]_e$, adenosine, bradykinin, prostaglandins, NO

Coronary Circulation

Control of coronary blood flow

2) the neural regulation of the vessel diameter – secondary impact
   a) indirect effects
   b) direct effects

X (mostly opposite)

Coronary Circulation

Control of coronary blood flow

2) the neural regulation of the vessel diameter – secondary impact

   a) indirect effects

      sympathetic system (NE, E)

      ↑ HR + contractility → rate of cardiac metabolism → increased O_2 consumption → activation of local vasodilating mechanisms

      parasympathetic system (ACH)

      opposite changes → vasoconstriction

Coronary Circulation

Control of coronary blood flow

2) the neural regulation of the vessel diameter – secondary impact
   a) indirect effects
   b) direct effects

vasospastic myocardial ischemia

sympathetic system (NE, E)

epicardial vessels – mostly α-rec. → vasoconstriction
intramural vessels – mostly β-rec. → vasodilation

parasympathetic system (ACH)

vasodilation, but not significant (only few fibers)

Coronary Circulation

Control of coronary blood flow

2) the neural regulation of the vessel diameter – secondary impact
   a) indirect effects
   b) direct effects

Whenever the direct effects alter the coronary blood flow in the wrong direction, the metabolic control overrides them within seconds!

Coronary Circulation

- **the resting blood flow:** 225 ml/min (4-5% of CO)
- **at physical exertion:**
  - cardiac output increased 4-7fold
  - higher afterload

  → cardiac work may increase 6-9fold

  - coronary blood flow increases only 3-4fold!

  ↓

  - efficiency of the cardiac utilization of energy has to increase to make up for the relative deficiency of coronary blood supply

Cardiac Muscle Metabolism

- at rest: 70% of energy – fatty acids
- anaerobic/ischemic conditions: anaerobic glycolysis

  high glucose consumption + high quantities of formed lactic acid (one of causes of the ischemic pain + ↓pH)
- severe ischemia: degradation of ATP to ADP, AMP and, finally, to adenosine → loss of adenosine into circulation through sarcolemma → vasodilation

  lost adenosine replaced by new synthesis of adenine, but very slowly (2% per hour)

  Major cause of death of cardiomyocytes during ischemia is the adenosine deprival! (30 min of severe ischemia may cause irreversible changes and cell death)

Coronary Reserve

- ability of coronary vessels to adapt blood flow to the actual cardiac work (**ergometry**)
- **the maximal blood flow / the resting blood flow**
- reduction of the coronary reserve:
  - relative coronary insufficiency
    (too high resting demands, high resting blood flow cannot be sufficiently increased)
  - absolute coronary insufficiency (~ coronary heart disease)
    (the stenotic arteriosclerotic process)

Reduced coronary reserve is a limiting factor of the cardiac output, thus, also of the effort of organism!