Would you expect type 1 or type 2 fibers in heart muscle?

Heart disease
What is a heart attack, what are short and long term causes of heart attacks?

Myocardial infarction

Adjustments to stroke volume

- End-diastolic volume 135 ml
- Stroke volume 70 ml
- End-systolic volume 65 ml

(a) Normal stroke volume

- End-diastolic volume 135 ml
- Stroke volume 100 ml
- End-systolic volume 35 ml

(b) Stroke volume during sympathetic stimulation

- End-diastolic volume 140 ml
- Stroke volume 140 ml
- End-systolic volume 35 ml

(c) Stroke volume with combination of sympathetic stimulation and increased end-diastolic volume
**Coronary artery disease**
Coronary arteries nourish cardiac cells

Blockage due to plaques, embolisms, vascular spasm

How cholesterol is carried in the blood:
- **High-density lipoprotein** - helps move cholesterol back to liver for removal
- **Low-density lipoprotein** - used by cells, excess LDL infiltrates artery walls

Saturated fats and trans fats in diet raise LDLs and promote plaque formation

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**Development of atherosclerosis involves these factors:**
- **Inflammation along vessel**, triggered by various factors (ox.LDLs, signals from fat, other inflam., smoking, hypertension)

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Inflammation promoted (LDL buildup, oxidation, WBCs are attracted and engulf LDLs). This area bulges into middle of vessel, can possibly rupture, 'snowball' effect.

Smooth muscle and fibroblasts (repair cells) may attempt to seal over the inflamed area, thickening it.

Development of atherosclerosis involves these factors:

- Blockage of grafted arteries
- Coronary bypass
- Poor circulation to heart muscle (blockage)
- High blood pressure makes heart work harder
- Insufficient valve

Coronary bypass

Heart disease

Often due to:
- Poor circulation to heart muscle (blockage)
- High blood pressure makes heart work harder
- Insufficient valve
Heart disease
Continued sympathetic action can temporarily alleviate heart failure effects on output.

Kidney fluid retention thus ↑stroke volume

Congestive heart failure
Stroke volume is so low that blood backs up in blood vessels leading to heart failure on left side - blood collects in pulmonary circuit and causes pulmonary edema. Oxygenation decreases.

Response of kidneys to ↑fluid retention is now problematic.

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What causes an enlarged heart?
Due to thickening of heart muscle:

- To pump against high pressure
- Leaking or stiffness in heart valves

Stiffness in aortic valve
What causes an enlarged heart?
Due to thickening of heart muscle:
- To pump against high pressure
- Leaking or stiffness in heart valves

Due to over-dilation due to heart failure (usually pulmonary edema)

What are heart arrhythmias?
- Arrhythmia: an irregularity in heart beat. There is an issue with electrical conductivity and/or rate (fibrillations, tachycardia, bradycardia)
- Arrhythmias don’t necessarily mean the person has heart disease (but can be a result)

Blood vessels are more than little tubes bringing blood to your body
They are dynamic, changing flow, growing branches according to conditions

Reconditioning of blood
Intestines, kidneys, and skin receive blood flow in excess to their needs
Resistance is the opposition to blood flow through a vessel. It depends on:

- blood viscosity
- vessel length
- vessel radius

Flow rate of blood

\[ F = \frac{\text{pressure gradient}}{\text{resistance}} \]  

or

\[ F = \frac{\Delta P}{R} \]

Effect of radius on surface area

Friction increases as surface area of contact increases

- more vessel wall in contact with blood
- less contact

Effect of radius on resistance

- Large radius of arteries, little resistance
- Elastic recoil from arteries drives flow of blood during diastole
- Arteries temporarily expand and hold pumped blood

Arteries are a pressure reservoir
Mean arterial pressure is the driving force for blood flow.

Mean arterial pressure = diastole pressure plus 1/3 the pulse pressure

$80 + \frac{1}{3} (40) = 93$

Blood pressure drops sharply once in arterioles.

Arterioles give most resistance

Arteriole radius changes to alter the distribution of blood and regulate blood pressure.

Vascular tone is a baseline of vascular resistance - changes in radius are possible.

Local control of arteriolar resistance

Mean blood pressure is identical to all organs.

Differences in arteriolar resistance determines the distribution of blood to different organs.

Mechanisms: endothelium cells release chemicals when $\downarrow$O$_2$ and $\uparrow$CO$_2$, $\uparrow$acidity.
Increased flow to skeletal muscles due to exercise

Extrinsic (outside) controls on arterioles:
Sympathetic signals cause general arteriole constriction, increasing mean pressure.

Local controls dilate arterioles where blood is needed.

Increased SNS

Local controls using signals from tissues
Capillaries

- O₂, CO₂ nutrients and wastes passively diffuse
- Thin vessels increase surface area of vessel wall contact

Diffusion at capillaries

- **Distance**: Walls are one cell thick
- **Area**: small radius, high surface area of contact
- **Speed**: small radius causes slow flow

Capillary walls have pores

- Pores allow the passage of small, water-soluble molecules (ions, glucose)
- Lipid-soluble substances dissolve through cell membrane

Bulk flow

Some substances cross the capillary wall by bulk flow of fluids

- **Ultrafiltration**
- **Reabsorption**
Bulk flow occurs by the changing differences in hydrostatic and osmotic pressures between plasma (inside) and interstitial fluid (outside).

When fluids leave capillaries, most plasma proteins remain.

Plasma has a higher concentration of proteins, producing osmotic pressure from interstitial fluid to plasma “Plasma-colloid osmotic pressure”.

Forces of bulk flow:
- Arteriole: Plasma colloid pressure, blood pressure (hydrostatic)
- Venule: Plasma colloid pressure, blood pressure (hydrostatic)
- Interstitial: Pressure

Ultrafiltration: 25
Reabsorption: 25
Blood pressure (hydrostatic): 37
**Bulk flow**

- Fluid is exchanged between plasma and interstitial fluid
- Site of short-term maintenance of fluid balance

**Lymphatic System**

Lymph formed from interstitial fluid

**Functions:**
- Drainage channels
- Absorption of fats from intestine
- Deliver pathogens to "nodes" where there are many lymphocytes

**Lymph nodes**

Armpit lumps caused by swollen lymph nodes
Lymphatic vessels

Fluid cannot push out from inside.