BIO 004 · HUMAN ANATOMY · SOLANO COMMUNITY COLLEGE

Week 3 Course Notes.

Cardiovascular · Respiratory

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BIO 004 · WEEK 3

Contents

The Heart

The Heart, Structures, Valves, and the Pathway of Blood

A reference for the heart video and lab. This page covers the heart wall and pericardium, the four chambers and four valves, cardiac muscle tissue, the pathway of blood through the heart, and the great vessels. The focus is on structure.

BY THE END

1. Name the layers of the heart wall and the pericardium.
2. Identify the four chambers and the four valves, and what each one separates.
3. Describe cardiac muscle tissue and the intercalated disc.
4. Trace the pathway of blood through the heart in order.

The Heart, an Overview

The heart is a hollow, muscular pump about the size of a closed fist. It sits in the mediastinum and drives blood through two circuits, one to the lungs and one to the body.

Heart	a hollow, muscular organ that pumps blood through the blood vessels
Location	in the mediastinum, between the two lungs, resting on the diaphragm and tilted to the left
Apex	the blunt, rounded inferior tip, pointing down and to the left
Base	the broad superior surface, where the great vessels enter and leave
Pulmonary circuit	the loop the right side of the heart drives, carrying blood to the lungs and back
Systemic circuit	the loop the left side of the heart drives, carrying blood to the body and back

The Heart Wall and Pericardium

The heart is wrapped in a double sac, the pericardium, and its own wall is built in three layers.

Pericardium	the double-walled sac that encloses the heart
Fibrous pericardium	the tough outer layer of dense connective tissue that protects the heart and anchors it in the mediastinum
Serous pericardium	the inner double membrane: a parietal layer lining the fibrous pericardium and a visceral layer on the heart surface
Pericardial cavity	the space between the two serous layers, holding a film of serous fluid that reduces friction as the heart beats

The heart wall itself has three layers. Compare them from outside in.

LAYER	POSITION	DESCRIPTION
Epicardium	the outer layer	the visceral layer of the serous pericardium, a thin serous membrane on the heart surface
Myocardium	the thick middle layer	cardiac muscle tissue, the bulk of the heart and the layer that contracts
Endocardium	the inner layer	a smooth endothelium lining the chambers and covering the valves, continuous with the lining of the great vessels

The Chambers

The heart has four chambers: two thin-walled atria that receive blood and two thick-walled ventricles that pump it out. Compare what each chamber receives and where it sends blood.

CHAMBER	RECEIVES BLOOD FROM	PUMPS BLOOD TO
Right atrium	the body, through the superior and inferior venae cavae, and the heart wall through the coronary sinus	the right ventricle
Right ventricle	the right atrium	the lungs, through the pulmonary trunk
Left atrium	the lungs, through the four pulmonary veins	the left ventricle

CHAMBER	RECEIVES BLOOD FROM	PUMPS BLOOD TO
Left ventricle	the left atrium	the body, through the aorta; its wall is the thickest of the four chambers

Interatrial septum	the wall between the two atria
Fossa ovalis	the oval depression in the interatrial septum, the remnant of the fetal foramen ovale
Interventricular septum	the thick wall between the two ventricles
Auricle	a small wrinkled pouch on each atrium that slightly increases its capacity

Pectinate muscles	parallel muscular ridges on the walls of the atria and the auricles
Trabeculae carneae	the irregular muscular ridges on the inner walls of the ventricles
Moderator band	a muscular band in the right ventricle that carries part of the conduction system to the papillary muscle

The Heart Valves

Four valves keep blood moving in one direction. Each opens to let blood pass and closes to stop it flowing back. Compare them by type and location.

VALVE	TYPE	LOCATION	PREVENTS BACKFLOW INTO
Tricuspid valve	atrioventricular, three cusps	between the right atrium and the right ventricle	the right atrium
Mitral valve	atrioventricular, two cusps; also called the bicuspid valve	between the left atrium and the left ventricle	the left atrium
Pulmonary valve	semilunar, three cusps	between the right ventricle and the pulmonary trunk	the right ventricle
Aortic valve	semilunar, three cusps	between the left ventricle and the aorta	the left ventricle

Chordae tendineae	strong fibrous cords that tie the cusps of an atrioventricular valve to the ventricle wall

Papillary muscles	cone-shaped muscle projections of the ventricle wall that anchor the chordae tendineae and hold the valves shut against pressure

Cardiac Muscle Tissue

The myocardium is built of cardiac muscle, a tissue found nowhere else in the body. Its structure lets the whole heart contract as one coordinated unit.

Cardiac muscle	the involuntary, striated muscle tissue that forms the myocardium
Cardiomyocyte	a cardiac muscle cell, short and branching, usually with a single central nucleus
Striations	cardiac muscle is striped, like skeletal muscle, because it too is built of ordered sarcomeres
Intercalated discs	the specialized junctions where neighboring cardiomyocytes meet end to end

Desmosomes	anchoring junctions within the intercalated discs that keep the cells from pulling apart
Gap junctions	channels within the intercalated discs that let the contraction signal pass directly from cell to cell
Abundant mitochondria	cardiac muscle is packed with mitochondria to fuel its constant, lifelong work

The Pathway of Blood

Follow one drop of blood through the heart, in order. It makes a full loop: into the right side, out to the lungs, back into the left side, and out to the body.

1. **Right atrium** oxygen-poor blood returns from the body through the superior and inferior venae cavae
2. **Tricuspid valve** blood passes from the right atrium down into the right ventricle
3. **Right ventricle** contracts and pumps the blood upward and out

4. **Pulmonary valve** blood passes into the pulmonary trunk, which branches to the lungs
5. **Lungs** blood picks up oxygen and releases carbon dioxide, then returns through the pulmonary veins
6. **Left atrium** receives the now oxygen-rich blood from the pulmonary veins
7. **Mitral valve** blood passes from the left atrium down into the left ventricle
8. **Left ventricle** the thickest chamber contracts and pumps the blood out with force
9. **Aortic valve** blood passes into the aorta and out to the body, completing the loop

The Great Vessels and Coronary Circulation

The great vessels are the large pipes attached to the base of the heart. The heart wall has its own blood supply, the coronary circulation.

The great vessels

Superior vena cava	returns oxygen-poor blood from the head, neck, and upper limbs to the right atrium	**Pulmonary veins**	four veins that return oxygen-rich blood from the lungs to the left atrium
Inferior vena cava	returns oxygen-poor blood from the trunk and lower limbs to the right atrium	**Aorta**	the largest artery, carrying oxygen-rich blood from the left ventricle to the body
Pulmonary trunk	carries blood from the right ventricle and branches into the right and left pulmonary arteries		

Coronary circulation

The heart wall has its own supply. The two coronary arteries leave the base of the aorta, run in the grooves on the heart's surface, and branch over the myocardium. The flow: aorta → coronary arteries → capillaries of the myocardium → cardiac veins → coronary sinus → right atrium.

CORONARY ARTERY	MAIN BRANCHES	REGION SUPPLIED
Right coronary artery (RCA)	right marginal artery; posterior interventricular artery (posterior descending, PDA)	right atrium, most of the right ventricle, part of the left ventricle, posterior septum, and usually the SA and AV nodes
Left coronary artery (LCA)	anterior interventricular artery (LAD); circumflex artery; left marginal artery	left atrium, left ventricle, anterior septum, and the apex

Coronary veins

Coronary sinus	the large vein on the posterior heart that collects the cardiac veins and empties into the right atrium	**Middle cardiac vein**	runs with the posterior interventricular artery (PDA)
Great cardiac vein	runs with the anterior interventricular artery (LAD)	**Small cardiac vein**	runs with the right marginal artery

Structure explains the emergency

The **coronary arteries** are the heart's own supply line, and they are narrow. When one is blocked, the patch of myocardium beyond it is starved of oxygen and its muscle begins to die. That is a heart attack, a myocardial infarction, and it is why the coronary vessels matter far beyond their small size.

A **valve** that does not close cleanly lets blood slip backward, and the turbulence is heard through a stethoscope as a murmur. The **chordae tendineae** and **papillary muscles** are what hold the atrioventricular valves shut against the force of a contracting ventricle; if a papillary muscle is damaged, the valve can fail.

Fluid building up in the **pericardial cavity**, called cardiac tamponade, squeezes the heart from outside and limits how much it can fill. The same fluid film that normally lets the heart glide can, in excess, stop it from working.

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Trace a drop of blood through the four chambers and four valves of the heart in order.
2. Compare the two atrioventricular valves and the two semilunar valves by location and what each prevents.
3. Name the layers of the heart wall and the membrane that surrounds the heart.
4. Explain how the great vessels connect the heart to the pulmonary and systemic circuits.

The Cardiac Conduction System

The Cardiac Conduction System and Disorders

A reference for the cardiac conduction video and lab. This page covers the conduction pathway and its components, the nerve supply to the heart, what an electrocardiogram records, and common conduction disorders.

BY THE END

1. Trace the conduction pathway from the SA node to the Purkinje fibers.
2. Locate each component of the conduction system and state its role.
3. Describe the nerve supply to the heart and what an ECG records.
4. Name common conduction disorders.

The Conduction System, an Overview

The heart sets its own beat. A network of specialized cardiac muscle cells, the conduction system, generates each heartbeat and spreads it so the chambers contract in the right order.

Cardiac conduction system	the network of specialized cardiac muscle cells that generates and spreads the signal for each heartbeat
Autorhythmicity	the heart's built-in ability to generate its own rhythm without a signal from the nervous system
Conducting cells	specialized non-contractile cardiac cells that generate and carry the electrical signal
Contractile cells	the ordinary working cardiomyocytes that contract when the signal reaches them
Why the order matters	the conduction system makes the atria contract first and the ventricles second, so each chamber fills before it empties

The Conduction Pathway

Each heartbeat travels a fixed route through the conduction system. Follow the signal in order, from the pacemaker to the ventricle walls.

1. **SA node** the sinoatrial node, the pacemaker; it fires first and sets the pace of the whole heart
2. **Across the atria** the signal spreads through both atria, and the atria contract
3. **AV node** the atrioventricular node; the signal pauses here briefly, giving the atria time to finish emptying
4. **AV bundle** the atrioventricular bundle, or bundle of His; it carries the signal into the interventricular septum, the only electrical link between the atria and the ventricles
5. **Bundle branches** the right and left bundle branches carry the signal down both sides of the interventricular septum toward the apex
6. **Purkinje fibers** spread the signal through the walls of both ventricles, and the ventricles contract from the apex upward

The Components of the Conduction System

The pathway is built from five named structures. Compare each by where it sits and what it does.

STRUCTURE	LOCATION	ROLE
SA node	the wall of the right atrium, near the opening of the superior vena cava	the natural pacemaker; it fires fastest and sets the heart rate
AV node	the floor of the right atrium, near the interatrial septum	delays the signal briefly, then passes it on to the ventricles
AV bundle	the superior part of the interventricular septum	the only electrical bridge from the atria to the ventricles
Bundle branches	the right and left sides of the interventricular septum	carry the signal down toward the apex of the heart
Purkinje fibers	throughout the walls of both ventricles	deliver the signal to the contractile cells of the ventricle walls

Nerve Supply to the Heart

The conduction system runs on its own, but the nervous system can speed it up or slow it down. Autonomic nerves reach the SA and AV nodes and adjust the rate to the body's needs.

Cardiac centers	regions of the medulla oblongata in the brainstem that adjust the heart rate
Cardiac plexus	the network of autonomic nerve fibers near the base of the heart through which these nerves reach the nodes
Sympathetic nerves	autonomic nerves that reach the heart through the cardiac plexus and speed the heart rate
Parasympathetic nerves	autonomic fibers carried in the vagus nerve that slow the heart rate
A modulating role	these nerves do not start the heartbeat; they only adjust the pace the SA node already sets

The Electrocardiogram

An electrocardiogram, an ECG or EKG, is a tracing of the heart's electrical activity recorded from the body surface. Each deflection of one heartbeat lines up with an event in the conduction system. Compare the three.

DEFLECTION	CONDUCTION EVENT	WHAT FOLLOWS
P wave	the signal spreads across the atria	the atria contract
QRS complex	the signal spreads across the ventricles	the ventricles contract
T wave	the ventricles electrically recover	the ventricles relax

Conduction Disorders

When the conduction system fails, the rhythm goes wrong. Compare the common disorders by what happens and why it matters.

DISORDER	WHAT HAPPENS	WHY IT MATTERS
Arrhythmia	any deviation from the normal heart rhythm	the umbrella term for the conduction disorders below
Tachycardia	an abnormally fast resting heart rate	the chambers may not have time to fill between beats
Bradycardia	an abnormally slow resting heart rate	the body may not receive enough blood flow
Heart block	the signal is delayed or stopped at the AV node	the atria and ventricles can beat out of step
Atrial fibrillation	rapid, disorganized signals in the atria	the atria quiver instead of contracting; common and treatable
Ventricular fibrillation	rapid, disorganized signals in the ventricles	the ventricles cannot pump; a life-threatening emergency
Ectopic pacemaker	a site outside the SA node takes over the rhythm	the normal pacing order of the heart is lost

When the rhythm needs help

An **artificial pacemaker** is a small implanted device that delivers a timed electrical signal to the heart. It takes over the job of a failing **SA node** or carries the signal past a block at the **AV node**, restoring an ordered beat.

In **ventricular fibrillation** the ventricles only quiver, so they move no blood. A defibrillator delivers a shock that stops all the chaotic signals at once, giving the SA node a chance to restart the heart in its normal rhythm.

The brief delay at the **AV node** is not a flaw, it is essential timing. It holds the signal just long enough for the atria to finish emptying into the ventricles before the ventricles contract, and an **ECG** is how a clinician reads whether that timing is intact.

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Trace an impulse through the cardiac conduction system in order, naming each structure.
2. Why does the impulse pause at the AV node, and what does that delay allow?
3. Explain why the SA node sets the heart rate even though other structures can also fire.
4. Connect the conduction pathway to the order in which the heart chambers contract.

Blood Vessels, Structure & Types

Blood Vessels, Structure and Types

A reference for the blood vessels video and lab. This page covers the three tunics of a vessel wall, the five vessel types, the kinds of artery, capillary, and vein, and the circulatory routes blood follows.

BY THE END

1. Name the three tunics of a vessel wall and what each contains.
2. Compare the five vessel types from artery to vein.
3. Distinguish the kinds of artery, capillary, and vein.
4. Describe the circulatory routes, including portal systems and anastomoses.

Blood Vessels, an Overview

Blood vessels are the body's plumbing. Blood leaves the heart in arteries, reaches the tissues through capillaries, and returns in veins.

Blood vessel	a tube that carries blood through the body
Artery	a vessel that carries blood away from the heart
Vein	a vessel that carries blood toward the heart
Capillary	the smallest vessel, where exchange between the blood and the tissues takes place
Lumen	the hollow interior of a vessel, the channel the blood flows through
The vascular sequence	arteries branch into arterioles, then capillaries, which merge into venules, then veins

The Three Tunics

The wall of an artery or a vein is built in three concentric layers, the tunics. A capillary wall is just the innermost layer. Compare the three.

TUNIC	POSITION	TISSUE	NOTE
Tunica intima	the innermost layer	a lining of simple squamous endothelium on a basement membrane	the only layer a capillary has
Tunica media	the middle layer	smooth muscle and elastic fibers	the thickest layer in arteries; its smooth muscle sets the vessel's diameter
Tunica externa	the outermost layer	mostly collagen fibers	anchors the vessel to the surrounding tissue

The Vessel Types

Blood passes through five kinds of vessel in series, each with a wall built for its job. Compare them.

VESSEL	DIRECTION OF FLOW	WALL	ROLE
Arteries	carry blood away from the heart	thick walls with a heavy tunica media	carry blood under high pressure
Arterioles	away from the heart, the smallest arteries	thinner walls, mostly smooth muscle	adjust how much blood enters a capillary bed
Capillaries	connect arterioles to venules	a single layer, the tunica intima only	the exchange vessels; gases and nutrients cross here
Venules	toward the heart, the smallest veins	thin walls	collect blood drained from the capillaries
Veins	carry blood toward the heart	thinner walls and a wide lumen, with valves	carry blood under low pressure

Arteries

Arteries carry blood away from the heart under high pressure. They come in three sizes, and the smallest control how much blood reaches the tissues.

Elastic arteries	the largest arteries, such as the aorta; their walls are rich in elastic fibers that stretch with each heartbeat and recoil between beats
Muscular arteries	medium-sized arteries that deliver blood to specific organs; their tunica media is mostly smooth muscle
Arterioles	the smallest arteries, the gatekeepers that control blood flow into the capillary beds
Vasoconstriction	the narrowing of a vessel as the smooth muscle of its wall contracts
Vasodilation	the widening of a vessel as the smooth muscle of its wall relaxes

Capillaries

Capillaries are the only vessels thin enough for exchange. They come in three types, leakier as the tissue's job demands. Compare them.

CAPILLARY TYPE	WALL	WHERE FOUND
Continuous capillary	an unbroken endothelial lining	the most common type, in muscle, skin, and the lungs
Fenestrated capillary	an endothelium with small pores, called fenestrations	where rapid absorption or filtration happens, as in the kidney and small intestine
Sinusoid	a wide, leaky vessel with large gaps between the cells	where even whole cells must cross, as in the liver, spleen, and bone marrow

Capillary bed	a network of capillaries supplied by a single arteriole
Precapillary sphincter	a ring of smooth muscle that opens or closes the entrance to a capillary
Vascular shunt	a direct channel that lets blood bypass the capillaries of a bed when exchange is not needed

Veins

Veins return blood to the heart under low pressure. Because the pressure is low, they rely on valves and on nearby muscles to keep blood moving the right way.

Venule	the smallest vein, collecting blood as it leaves a capillary bed
Vein	a vessel returning blood to the heart, with a thinner wall and a wider lumen than the matching artery
Venous valves	flaps of the tunica intima, common in the limb veins, that keep blood from flowing backward
Skeletal muscle pump	contracting limb muscles that squeeze the deep veins and push blood toward the heart
Blood reservoirs	the veins as a group, which at rest hold the largest share of the body's blood

Circulatory Routes

Most blood follows the simple loop of artery to capillary to vein, but a few routes are arranged differently.

Pulmonary circuit	the route from the right side of the heart to the lungs and back to the left side
Systemic circuit	the route from the left side of the heart out to the body and back to the right side
Portal system	an arrangement in which blood passes through two capillary beds in series before returning to the heart, as in the hepatic portal system that routes blood through the liver
Anastomosis	a place where two vessels join, giving blood an alternate route if one path is blocked

Arteriovenous anastomosis	a direct connection from an artery to a vein that bypasses the capillaries

Why the wall built for the job matters

Blood is drawn and IV lines are placed in **veins**, not arteries. A vein sits closer to the surface, has a thinner wall and a wider lumen, and runs at low pressure, so it is easy to enter and slow to bleed. Its **valves** can even be seen as small bumps along a forearm vein.

The **capillary** type is matched to the tissue. The leaky **sinusoids** of the liver and spleen let whole blood cells pass, while the tight **continuous capillaries** of the brain keep most substances out. The same vessel name, built three different ways, does three different jobs.

The elastic recoil of the **aorta** keeps blood moving between heartbeats. When elastic arteries stiffen with age, that cushioning is lost, and the strain shows up downstream in the smaller vessels.

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Compare the three vessel types, artery, capillary, and vein, by wall thickness and the job each does.
2. Why do veins have valves and arteries do not? Tie your answer to blood pressure.
3. Trace blood from the left ventricle to a capillary bed and back to the right atrium, naming the vessel types in order.
4. Explain how the structure of a capillary suits exchange between blood and tissue.

Blood Vessel Disorders & Fetal Circulation

Blood Vessel Disorders and Fetal Circulation

A reference for the blood vessel disorders and fetal circulation video and lab. This page covers atherosclerosis and the common arterial and venous disorders, then the special circulation of the fetus and what its shunts become after birth.

BY THE END

1. Describe atherosclerosis and how it changes an artery wall.
2. Name common arterial and venous disorders.
3. Explain how fetal circulation differs from the adult plan.
4. Name the fetal shunts and the adult remnant each one becomes.

An Overview

This page covers two topics. First, the common disorders of blood vessels, which mostly narrow or weaken the vessel wall. Second, fetal circulation, the rearranged plan a fetus uses before its lungs work.

Healthy vessel	a vessel with a smooth endothelial lining and a wall that can stretch and recoil
Vascular disorder	a disease of a blood vessel; most disorders narrow the lumen, weaken the wall, or let blood pool
Fetal circulation	the circulatory plan of a fetus, which gets its oxygen from the placenta rather than from its own lungs
Shunt	a special vessel or opening that routes blood around an organ; the fetus uses shunts to bypass the lungs and liver

Atherosclerosis

Atherosclerosis is the most important vessel disease, the root of heart attacks and strokes. It is a slow, structural change in the artery wall.

Atherosclerosis	a disease in which fatty plaques build up within the walls of arteries
Endothelial injury	damage to the smooth tunica intima lining, the starting point of a plaque
Atheroma	also called a plaque, a deposit of fatty material, cells, and debris within the artery wall
Narrowed lumen	as a plaque grows it bulges inward, narrowing the channel and reducing blood flow
Arteriosclerosis	the general stiffening and thickening of artery walls; atherosclerosis is its most common form
Thrombus	a clot that can form on a roughened plaque and suddenly block the vessel

Arterial Disorders

Arteries carry blood under high pressure, so their disorders tend to narrow the channel or weaken the wall. Compare the common ones.

DISORDER	WHAT IT IS	WHY IT MATTERS
Aneurysm	a balloon-like bulge in a weakened artery wall	it can rupture; common in the aorta and the arteries of the brain
Atherosclerosis	fatty plaque buildup that narrows an artery	the leading cause of coronary artery disease and stroke
Coronary artery disease	narrowing of the coronary arteries that supply the heart wall	can starve the myocardium and cause a heart attack
Peripheral artery disease	narrowing of the arteries of the limbs, usually the legs	causes pain on walking as the muscles are starved of blood
Hypertension	chronically high pressure within the arteries	strains the heart and damages vessel walls over time
Stroke	loss of blood supply to part of the brain, from a blocked or burst artery	brain tissue begins to die within minutes

Venous Disorders

Veins carry blood under low pressure, so their disorders tend to involve failed valves and pooled or clotted blood. Compare the common ones.

DISORDER	WHAT IT IS	WHY IT MATTERS
Varicose veins	superficial veins that become twisted and swollen when their valves fail	blood pools and the veins bulge visibly, most often in the legs
Deep vein thrombosis	a blood clot in a deep vein, usually of the leg	the clot can break free and travel through the bloodstream
Pulmonary embolism	a clot, often from a deep vein, that lodges in an artery of the lung	a life-threatening emergency that blocks blood flow to the lung
Phlebitis	inflammation of a vein	causes pain, redness, and tenderness along the vein
Hemorrhoids	varicose veins of the rectal and anal region	a common cause of rectal discomfort and bleeding
Chronic venous insufficiency	long-term failure of the valves of the leg veins	leads to persistent swelling and skin changes in the lower leg

Fetal Circulation, an Overview

Before birth, a fetus does not breathe air or digest food, so its circulation is rearranged. Oxygen and nutrients come from the placenta, and blood is routed around the organs that are not yet in use.

The placenta	the organ where fetal blood picks up oxygen and nutrients from the mother and gives up wastes
Umbilical cord	the cord connecting the fetus to the placenta, carrying the umbilical vessels
The lungs are bypassed	the fetal lungs are collapsed and not used for gas exchange, so most blood is routed around them
The liver is largely bypassed	much fetal blood skips the liver, since the placenta handles that filtering
Three shunts	the ductus venosus, the foramen ovale, and the ductus arteriosus, the detours that route blood around the liver and lungs

The Fetal Vessels and Shunts

Five special structures carry and reroute fetal blood. Compare what each one is and what it does.

STRUCTURE	WHAT IT IS	WHAT IT DOES
Umbilical vein	a vein in the umbilical cord	carries oxygen-rich blood from the placenta to the fetus
Ductus venosus	a shunt passing through the fetal liver	lets most blood bypass the liver and flow straight toward the inferior vena cava
Foramen ovale	an opening in the interatrial septum	lets blood pass directly from the right atrium to the left atrium, bypassing the lungs
Ductus arteriosus	a short vessel between the pulmonary trunk and the aorta	lets blood bypass the lungs by shunting it from the pulmonary trunk into the aorta
Umbilical arteries	two arteries in the umbilical cord	carry oxygen-poor blood from the fetus back to the placenta

The Shunts After Birth

At birth the lungs inflate and the placenta is cut off. Each fetal shunt is no longer needed, closes, and is left behind as a small ligament or remnant. Compare each one with what it becomes.

FETAL STRUCTURE	ADULT REMNANT	NOTE
Umbilical vein	the ligamentum teres, the round ligament of the liver	runs in the free edge of the falciform ligament
Ductus venosus	the ligamentum venosum	a fibrous cord on the inferior surface of the liver
Foramen ovale	the fossa ovalis	a shallow oval depression in the interatrial septum
Ductus arteriosus	the ligamentum arteriosum	a short cord between the pulmonary trunk and the aorta

FETAL STRUCTURE	ADULT REMNANT	NOTE
Umbilical arteries	the medial umbilical ligaments	paired cords on the inner surface of the anterior abdominal wall

When the detour does not close

The fetal shunts are meant to close in the first hours and weeks after birth. When the **ductus arteriosus** stays open, the result is a patent ductus arteriosus; when the **foramen ovale** stays open, a patent foramen ovale. Both leave an abnormal connection between the two sides of the circulation, and both are named for the fetal structure that failed to seal.

Atherosclerosis ties the disorders together. A plaque that narrows a coronary artery causes a heart attack; one that narrows or bursts a brain artery causes a stroke; one in the leg causes peripheral artery disease. The same wall change, in different vessels, names different diseases.

A **deep vein thrombosis** in the leg is dangerous for where the clot can go. If it breaks free, it travels up the venae cavae, through the right heart, and lodges in a lung artery as a **pulmonary embolism**. The route the clot takes is just the normal venous return.

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Compare an aneurysm and an atherosclerotic plaque by what each does to the vessel wall.
2. Explain, anatomically, why a deep vein thrombosis is dangerous if part of it breaks loose.
3. Why are varicose veins a problem of the veins and their valves rather than the arteries?
4. Contrast an ischemic and a hemorrhagic stroke by what happens to the blood vessel.

The Respiratory System

The Respiratory System

A reference for the respiratory system video and lab. This page covers the upper and lower respiratory tracts, the larynx, the bronchial tree, the lungs and pleurae, the alveoli, and common respiratory disorders. The focus is on structure.

BY THE END

1. Distinguish the upper and lower respiratory tracts and the conducting and respiratory zones.
2. Identify the parts of the larynx and the bronchial tree.
3. Describe the lungs, the pleurae, and the structure of an alveolus.
4. Name common respiratory disorders.

The Respiratory System, an Overview

The respiratory system moves air in and out and brings it close to the blood. Its parts are grouped two ways: upper and lower tract, and conducting and respiratory zone.

Respiratory system	the organs that move air and bring it close to the blood for gas exchange
Upper respiratory tract	the nose, nasal cavity, paranasal sinuses, and pharynx
Lower respiratory tract	the larynx, trachea, bronchi, and lungs
Conducting zone	the passages that only carry air, from the nose to the terminal bronchioles
Respiratory zone	the structures where gas exchange happens: the respiratory bronchioles, alveolar ducts, and alveoli
A note on scope	this page covers the structure of the system; the exchange of gases is a physiology topic and is not covered here

The Upper Respiratory Tract

The upper tract takes in air and conditions it, warming, moistening, and filtering it before it reaches the lungs.

Nose	the external nose and the nasal cavity, the main entry point for air
Nasal cavity	the space behind the nose, divided into right and left halves by the nasal septum
Nasal vestibule	the entrance just inside the nostrils, lined with skin and coarse hairs (vibrissae) that filter large particles
Nasal conchae and meatuses	the scroll-shaped conchae on the lateral walls, with the superior, middle, and inferior meatuses (air passages) beneath them, that swirl the air over the warm, moist lining
Paranasal sinuses	air-filled cavities in the frontal, ethmoid, sphenoid, and maxillary bones that drain into the nasal cavity
Pharynx	the throat, a muscular passage shared by air and food
Nasopharynx	the upper part of the pharynx, behind the nasal cavity, an air-only passage
Oropharynx	the middle part of the pharynx, behind the mouth, shared by air and food
Laryngopharynx	the lower part of the pharynx, which opens into both the larynx and the esophagus

The Larynx

The larynx, the voice box, connects the pharynx to the trachea. It keeps food out of the airway and houses the vocal cords.

Larynx	the voice box, the airway between the pharynx and the trachea
Thyroid cartilage	the large shield-shaped cartilage forming the laryngeal prominence, the Adam's apple
Cricoid cartilage	the ring-shaped cartilage just below the thyroid cartilage
Epiglottis	the flexible flap that folds down over the laryngeal opening during swallowing to keep food and drink out of the airway
Arytenoid cartilages	the paired cartilages that anchor and move the vocal cords

Vocal cords	also called the vocal folds, the paired folds that vibrate as air passes to produce sound
Glottis	the opening between the vocal cords

The Trachea and Bronchial Tree

Below the larynx the airway becomes a branching tree, growing narrower and more numerous at every division. Follow the path of air in order.

1. **Trachea** the windpipe, held permanently open by C-shaped rings of cartilage
2. **Carina** the internal ridge where the trachea forks into the two main bronchi
3. **Main bronchi** the primary bronchi, one entering each lung
4. **Lobar bronchi** the secondary bronchi, one to each lobe of the lung
5. **Segmental bronchi** the tertiary bronchi, one to each bronchopulmonary segment
6. **Bronchioles** the smallest conducting airways, with smooth muscle walls and no cartilage
7. **Terminal bronchioles** the last airways of the conducting zone, just before gas exchange begins

The Lungs and Pleurae

The two lungs fill most of the thoracic cavity. They are not identical: the left lung gives up room for the heart. Compare them.

LUNG	LOBES	FISSURES	NOTE
Right lung	three: superior, middle, and inferior	a horizontal fissure and an oblique fissure	the larger of the two lungs
Left lung	two: superior and inferior	an oblique fissure only	smaller, with a cardiac notch that makes room for the heart

Apex	the narrow superior tip of a lung, rising just above the clavicle
Base	the broad inferior surface of a lung, resting on the diaphragm
Hilum	the indentation on the medial surface where the bronchus and vessels enter and leave
Parietal pleura	the serous membrane lining the thoracic wall
Visceral pleura	the serous membrane covering the outer surface of the lung
Pleural cavity	the thin, fluid-filled space between the two pleurae that lets the lung glide as it expands

The Respiratory Zone and the Alveoli

Past the terminal bronchioles the airway becomes the respiratory zone, where the walls thin out into air sacs and gas exchange becomes possible.

Respiratory bronchioles	the first airways of the respiratory zone, with a few alveoli budding from their walls
Alveolar ducts	passages whose walls are lined entirely with alveoli
Alveoli	the tiny air sacs that are the site of gas exchange; the lungs hold hundreds of millions of them
Alveolar sac	a cluster of alveoli that share a common space
Type I alveolar cells	the thin, flat cells that form most of the alveolar wall, where gases cross
Type II alveolar cells	the cells that secrete surfactant, which lowers surface tension and keeps the alveoli from collapsing
Alveolar macrophages	the "dust cells" that crawl over the alveolar surface and engulf inhaled debris and microbes
Respiratory membrane	the thin barrier between the alveolar air and the blood, across which gases cross
Pulmonary capillaries	the dense net of capillaries wrapping each alveolus

Respiratory Disorders

Respiratory disorders mostly block airflow or damage the surface where gases cross. Compare the common ones by the structure each one affects.

DISORDER	STRUCTURE AFFECTED	WHAT IT IS
Asthma	the bronchioles	inflammation and narrowing of the bronchioles, causing wheezing and breathlessness
COPD	the airways and alveoli	chronic obstructive pulmonary disease, a long-term blockage of airflow that includes emphysema and chronic bronchitis
Emphysema	the alveoli	destruction of the alveolar walls, which reduces the surface available for gas exchange
Pneumonia	the alveoli	an infection that inflames the alveoli and fills them with fluid
Pneumothorax	the pleural cavity	air in the pleural cavity, which breaks the seal and lets the lung collapse
Lung cancer	the lung tissue	a malignant tumor of the lung, strongly linked to smoking

Why the design has weak points

The **epiglottis** normally seals the airway during a swallow. When something slips past it, a coughing fit is the airway's attempt to clear it. Because the right main bronchus is wider and more vertical than the left, an inhaled object most often lands in the right lung.

The **alveoli** give the lungs an enormous surface, but it is fragile. Emphysema destroys alveolar walls and merges many small sacs into a few large ones, trading a huge exchange surface for a small one. The change is structural and permanent.

The **pleural cavity** is sealed and holds only a thin film of fluid. If the chest wall or lung is punctured, air enters that space, the seal is lost, and the lung collapses, a pneumothorax. The structure that lets the lung glide is also what makes it vulnerable.

Study questions

Work on answering these in writing, in your own words. They are the questions to bring to class, and good practice for the reasoning the exams ask for.

1. Compare the conducting zone and the respiratory zone by structure and where gas exchange happens.
2. Trace a breath of air from the nose to an alveolus, naming each structure in order.
3. Explain how the structure of an alveolus suits gas exchange.
4. Name the muscles of breathing and explain how they change the size of the thoracic cavity.