

Elements

Hemocytoblasts (Stem Cell)	Hematopoiesis (Production in bone)	Chemical/Hormone	Location
Erythrocytes (RBCs)	Erythropoiesis	Erythropoietin (EPO)	1. Kidneys 2. Liver
Leukocytes (WBCs)	Leukopoiesis	Cytokines	Macrophages & T-Lymphocytes
Thrombocytes (Platelets)	Thrombopoiesis	Thrombopoietin	1. Liver 2. Kidneys

Blood

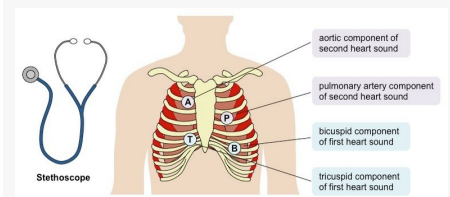
Blood (cont)

Blood (cont)

Albumin

Most abundant protein

APTM Heart sounds





Blood Types

Blood Type Compatibility

A blood type is a classification of blood based on the presence or absence of antigens on the surface of red blood cells. Human blood is divided into one of four main blood types: A, B, AB, and O, and is further divided into Rh+ or Rh-.

		You can receive type							
		O+	O-	A+	A-	B+	B-	AB+	AB-
If you are type	O+	●	●						
	O-	●	●						
	A+	●	●	●	●				
	A-	●	●	●	●				
	B+	●	●			●	●		
	B-	●	●			●	●		
	AB+	●	●	●	●	●	●	●	●
	AB-	●	●	●	●	●	●	●	●

Heart Valves



Heart

Systole/ Diastole **Systole**~ Contraction of the heart muscles. **Diastole**~ Relaxation of the heart muscles

Papillary Muscles Contract & generate tension on chordae tendinae

Cardiac Reserve Difference between resting and maximal cardiac output

Function of the Spleen

Graveyard. Dying RBCs are recycled in the spleen, liver, and red bone marrow by macrophages.

White Blood Cells

Never Let Monkeys Eat Bananas.

Neutrophils, Lymphocytes, Monocytes, Eosinophils, Basophils. **Leukocytes** ~ There are 5 types of leukocytes organized into two classes. those are **Agranular**, which consists of lymphocytes (20-25%) & monocytes (3-8%). **Granular**, which consists of basophils (.5-1%) neutrophils (60-70%) & eosinophils (2-4%)

Neutrophils

Nucleus 2-5 lobes / Our bodies "Bacteria Slayers" / Initiate **respiratory bursts** to kill bacteria / Produce antibiotic-like proteins called **defensins**

Lymphocytes

Large single, dark purple, mostly made of lymph tissue. T-cells- AcT against virus-infected cells & Tumor cells. Thymus- immunocompetence/mature. **B-cells- Become plasma cells** which produce **antibodies**; Bone marrow- immunocompetence/mature

Monocytes

Dark purple *kidney* or U-shaped nuclei. Largest leukocyte. Leave circulation and enter tissue- turn to **macrophages**. Activate lymphocytes from immune response by releasing cytokines.

Eosinophils

Red-staining, bi-lobed. Digest parasitic worms. Lessen the severity of allergies.

Basophils

Rarest WBCs. U or S-shaped. Contain large purplish-black granules. Histamine (vasodilator) & heparin (anticoagulant) attracts other WBCs to inflamed sites & **bronchoconstriction**

Normal pH range for blood

7.35-7.45

Response to injury/hemostasis

Stoppage of bleeding. 1~Vascular Spasm 2~ Platelet Plug 3~Coagulation

Thrombocytes (Platelets)

Megakaryocyte-Cytoplasmic cell fragments. Form a temporary plug to seal vessels

Leukocytes (WBC's)

Are complete cells (They have a nucleus and organelles)

Erythrocytes (RBC's)

Mature RBC's have no nuclei or organelles (live approx. 120 days)

Hypoxia

Too few RBCs (anemia)

Erythropoietin (EPO)

Direct stimulus for erythropoiesis Released by kidneys in response to "hypoxia"

Hematopoiesis (Hemopoiesis)

is the proliferation and differentiation of the formed elements of blood originating from a **Hemocytoblast** (stem cell).

Polycythemia

excess RBCs > inc blood viscosity > heart attack or stroke. **Polycythemia vera**~Bone marrow cancer due to a gene mutation. **Secondary polycythemia**~less O2 available or inc EPO. **Blood doping**~ (excess blood transfusions)

Leukemia

cancerous conditions of abnormal production (increased #) Leukemias are named according to the abnormal WBCs involved **Myelocytic leukemia**~involves myeloblasts **Lymphocytic leukemia**~involves lymphocytes (Acute: quickly developing; primarily affects children Chronic: slow to develop; more prevalent in older people)

Location of Hematopoiesis

Red Bone Marrow



Heart (cont)

Angina Pectoris Pain due to deficient blood supply to the myocardium. Caused by transient stress-induced spasms of coronary arteries, increased physical demands on the heart or arteriosclerosis. Cells are weakened.

Myocardial Infarct **Heart Attack**. Prolonged coronary blockage= prolonged lack of oxygen to the heart muscles= cardiac muscle cell death. These cells are AMITOTIC; replaced with non-contractile scar tissue. May be repairable depending on the extent of the damage and time

Heart (cont)

Layers of the Heart **Epicardium** aka visceral pericardium- visceral layer of the serous pericardium. **Myocardium**- Spiral bundles of cardiac muscle cells held together by elastic & collagen fibers that form a dense network called the *Fibrous Skeleton* of the heart. **Endocardium** innermost- Endothelial layer of the inner myocardial surface that is continuous with blood vessel linings. Creates a smooth surface for easy blood flow.

Contraction of the Heart **Sinoatrial node (SA Node-Pacemaker)** 60-100 beats/min. **Atrioventricular node (AV Node)** 40-60 beats/min. **Atrioventricular (AV) bundles (Bundle of His)** 0-40 beats/min **Right and Left bundle branches** 0-40 beats/min **Ventricular Purkinje Fibers** 0-40 beats/min

Heart (cont)

Lub/Dub sounds Caused by the closing of heart valves. **First Sound**~ occurs as AV valves close and signifies beginning of systole (contraction). **Second Sound**~ occurs when SL valves close at the beginning of ventricular diastole (relaxed)

Pathway of blood through Heart (Pulmonary circuit) Right atrium-tricuspid valve-- right ventricle-pulmonary semilunar valve-pulmonary arteries-Lungs-pulmonary veins-left atrium

Pathway of blood through Heart (Systemic circuit) Left atrium-bicuspid (mitral) valve-Left ventricle-aortic semilunar valve-aorta-to the body-vena cava-right atrium



Heart (cont)

Isovol- umetric contra- ction/- rel- axation	isovolumetric Contraction ~ All 4 valves are closed. Atria relax; ventricles contract (0.3 seconds) Isovolumetric Relaxation ~ All 4 valves are closed. Occurs in early diastole. Ventricles relax. Backflow of blood in aorta and pulmonary trunk closes semilunar valves. Quiescent period (0.4 seconds)
Ventri- cular Filling	Takes places mid-to-late diastole. Atrial contraction (0.1 seconds). AV valves are open. 80% of blood passively flows into ventricles. Remaining 20% delivered with atrial systole. Heart blood pressure is low as blood enters atria and flows into ventricles.

Heart (cont)

Develo- pment aspects of the heart	Fetal heart structures that bypass pulmonary circulation. Forman Ovale ~ connects the two atria. After birth this closes and becomes the Fossa Ovalis . Ductus Arteriosus ~ connects pulmonary trunk and the aorta. After birth this closes and becomes the Ligamentum Ateriosum
Cardiac Output Equation	$CO = SV \text{ (Stroke Volume)} \times HR \text{ (Heart Rate)}$ If HR or SV goes up so does CO; same is true for going down
Stroke Volume Equation	$SV = EDV \text{ (End Diastolic Volume)} - ESV \text{ (End Systolic Volume)}$ EDV~ amount of blood collected in a ventricle during diastole (120ml) ESV~ amount of blood remaining in a ventricle after contraction (50ml) Average Stroke Volume~ 70ml
Norepi- nephrine	Sympathetic neuron activation releases Norepinephrine

Heart (cont)

Acetyl- choline	Parasympathetic fibers in the vagus nerves release Acetylcholine . If vagus nerves are cut= inc HR by ~ 25 bpm (THIS IS CALLED VAGAL TONE)
Congestive Heart Failure (CHF)	The heart is a "double pump" and each side can initially fail independently of the other. LEFT SIDE ~ Pulmonary congestion~ blood backing up into the lungs > pulmonary edema. Can lead to suffocation. RIGHT SIDE ~ Peripheral Congestion~ blood backs up at the tissue level > edema in the extremities. Can lead to tissue hypoxia.



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Published 27th March, 2022.
Last updated 28th March, 2022.
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Heart (cont)

Commotio Cordis Often lethal disruption of heart rhythm that occurs as a result of a blow to the area directly over the heart, at a critical time during the cycle of a heart beat causing cardiac arrest. It is a form a ventricular fibrillation, not mechanical damage to the heart muscle or surrounding organs, and not the result of heart disease.

Normal blood pressure in Pulmonary Trunk 24/8 mmHg

Blood Vessels

Arteries/Arterioles

Always carry blood away from the heart; oxygenated **except** for pulmonary circulation and umbilical vessels of fetus.

ARTERIOLES~Smallest arteries; lead to capillary beds. Control blood flow into capillary beds via sympathetic nervous system vasoconstriction (increased release of norepinephrine) and vasodilation (decreased release of norepinephrine)

Veins/Venules

Always carry blood toward the heart; deoxygenated **except** in pulmonary circulation and umbilical vessel of fetus

Blood Vessels (cont)

Veins

Special adaptations to ensure return blood: Large-diameter lumens: offer little resistance to blood flow Valves prevent backflow of blood Varicose veins and hemorrhoids are the result of incompetent valves (valve failure).

Capillaries

Contact tissue cells and directly serve cellular needs. Smallest blood vessels (microscopic). Walls consisting of thin tunica intima, one cell thickness. Diameter only allows a single RBC to pass at a time. Function: exchanges of gases, nutrients, and metabolic wastes between tissue and blood.

Neurotransmitter released by Sympathetic and Parasympathetic

Sympathetic~ NE-Norepinephrine

Parasympathetic~ACH-Acetylcholine

Antidiuretic Hormone (ADH) effects of blood pressure

released when BP falls very low causes intense vasoconstriction >> inc BP Also stimulates kidneys to conserve water

Mean Arterial Pressure (MAP) Equation

pressure that propels blood through tissues. $MAP = \text{Diastolic} + \frac{\text{Pulse Pressure}}{3}$ (Example BP of 110/70 $MAP = 70 + \frac{110 - 70}{3}$)

Blood Vessels (cont)

Renin-angiotensin and effects of Angiotensin II and Aldosterone

Renin-angiotensin has a major effect on the cardiovascular system. Renin is an enzyme, although some sources identify it as a hormone. Renin converts the plasma protein angiotensinogen which is produced by the liver, into its active form **angiotensin I**. **angiotensin I** circulates in the blood and is then converted into **angiotensin II** in the lungs. **Angiotensin II** is a powerful vasoconstrictor, greatly increasing blood pressure. It also stimulates the release of ADH and **aldosterone**. (Angiotensin II~ released in low renal perfusion (decreased BP). Kidney are stimulated to release of renin which generates angiotensin II. Initially creates vasoconstriction (short term)->inc BP. Long term >> *stimulates aldosterone and ADH release*>>inc blood volume>>inc BP)

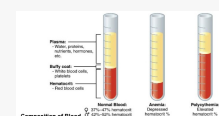
Blood pressure Equation

$BP = CO \text{ (Cardiac Output)} \times PR \text{ (Peripheral resistance)}$

Blood Pressure Chart

BLOOD PRESSURE CATEGORY	SYSTOLIC (mm Hg) (upper number)	DIASTOLIC (mm Hg) (lower number)
Normal	120 (normal)	80 (normal)
Elevated	120-130	80-85
High Blood Pressure (Hypertension) Stage 1	130-139	80-89
High Blood Pressure (Hypertension) Stage 2	140 or higher	90 or higher
Hypertensive Crisis (seek your doctor immediately!)	Higher than 180	Higher than 120

Blood Comp



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Published 27th March, 2022.
Last updated 28th March, 2022.
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