Human Blood Groups

Which naturally produce what antibodies?

Type A- Anti B antibody

Type B- Anti A antibody

Type AB- Neither antibodies

Type O- Both A and B antibodies

Red Blood Cells

What happens during development and the name of each stage

Developing RBCs lose their nucleus and many other organelles as they mature

When a maturing RBC loses it's nucleus, it becomes a reticulocyte

The mature form is highly specialized for oxygen transport

Red Blood Cells

What is hemoglobin and what does it do?

Hemoglobin is a protein molecule adapted to carry O2

Red Blood Cells

How are old RBCs destroyed

Ruptured RBCs are removed from circulation and destroyed by fixed phagocytotic macrophages in the spleen and liver

Abnormalities of Erythropoiesis

List some causes

low iron intake, hemolysis, autoimmune disease, blood loss, or lack of production in the bone marrow

Anemias

What is sickle-cell disease and how are RBC affected?

An autosomal recessive disorder

A genetic defect in the primary DNA sequence leads to production of a faulty Hgb β chain, and RBCs that take on a rigid, sickle-shape

Formed Elements

What are WBCs and list characteristics discussed in PPT

leukocytes

Have nuclei and a full complement of other organelles

do not contain the protein Hgb

Shorter life-span compared to RBCs

divided into two groups depending on whether they contain conspicuous chemical-filled cytoplasmic granules (when stained) Granulocytes Agranulocytes

Human Blood Groups

What is the Rh antigen?

is an inherited protein found on the surface of red blood cells

Human Blood Groups

What is special about antibody production in negative individuals?

Anti-Rh antibodies not spontaneously formed in Rh– individuals

Anti-Rh antibodies form if Rh– individual receives Rh+ blood, or Rh– mom carrying Rh+ fetus

The Circulatory System

Where is the heart located in the thoracic cavity?

The heart is located in the mediastinum, which extends from the sternum anteriorly to the vertebral column posteriorly, and lies medially between the two lungs and the pleural membranes that cover them.

Heart Location

How is it oriented?

The heart is located in the middle mediastinum.

Base

The base of the heart is tipped up medially and posteriorly

Heart Location (cont)

Apex

> the apex projects inferiorly and laterally.

Chambers Of The Heart

List the 4 chambers of the heart

> Right Atrium Right Ventricle Left Atrium Left Ventricle

Chambers Of The Heart

Right heart and pump

> consists of the right atrium and right ventricle Takes in venous blood from the body and pumps it to the lungs for oxygenation.

Left heart and pump

> consists of the left atrium and left ventricle Takes in freshly oxygenated pulmonary blood and pumps it systemically (meaning to the body).

Top pump

> A weak pump consisting of the right and left atria. The atria receive venous blood and top-off the ventricles by giving an “atrial kick” (atrial contraction) before the ventricles contract.

Chambers Of The Heart (cont)

Bottom pump

> A strong pump consisting of the right and left ventricles – pumps out to arteries It’s the main pump for the pulmonary and systemic circuits.

Cardiac Muscle Tissue: Electrophysiology

List basic electrophys differences with skeletal muscle

> Action potential and contractile phase last much longer in contractile cardiac myocytes

> extends absolute refractory period and allows time for proper contraction necessary for pressure build up needed for ejection of blood from heart chamber

> Return to repolarization results from inactivation of Ca2+ channels during the open period of voltage-gated K+ channels

> Ca2+ pumped back into SR and extracellular fluid

> Long absolute refractory period (250 ms)

> Another Action potential and contraction cannot begin until relaxation is well underway. For this reason, tetanus (sustained contraction) cannot occur in cardiac muscle This allows for sufficient time between contractions for the chambers to fill with blood – cannot properly fill if contracting

Autorhythmicity

How are they connected to each other and to the contractile cardiac myocytes?

> The conducting system is in contact with the contractile cardiac myocytes via gap junctions

What are those connections used for?

> Once a group of autorhythmic cells reaches threshold and start an action potential (AP), all of the cells in that area of the heart also depolarize by spread of ions through gap junctions.

Cardiac Conduction: Sequence of Excitation

What is the SA node and why is it the pacemaker?

> Pacemaker of heart in right atrial wall

> Depolarizes faster than rest of non-contractile myocardium

What is the AV node and why is it important?

> In inferior interatrial septum (separation line between atria)

> Allows atrial contraction to mostly complete prior to conducting the AP that will be responsible for ventricular contraction

What is the AV bunde and what is its job?

> In superior interventricular septum (separation line between ventricles)

> Only electrical connection between atria and ventricles

Cardiac Conduction: Sequence of Excitation (cont)

Basics of right and left bundle branches

- Two pathways in interventricular septum

- Carry impulses toward apex of heart

What is the Subendocardial network and why is it important?

- Complete pathway through interventricular septum into apex and ventricular walls

- More elaborate on left side of heart - more muscle mass

- AV bundle and subendocardial conducting network depolarize 30X/minute in absence of AV node input

Leukocytes

Why is it important for WBC function

- This allows them to pinpoint the area of damage/inflammation/infection and gather in large numbers to remove debris and fight infection

Granulocytes

List the granulocytes, the role of each, and their relative abundance

- Neutrophil

- The most numerous WBC in normal blood (50-70% of circulating white blood cells)

- PMNs are granulocytes with a pinkish cytoplasm

- one of the two major phagocytes in the body

Granulocytes (cont)

- their principal role is to fight bacterial infections

- Use a variety of chemicals destroy pathogens

- Eosinophils

- Characterized by their large red granules

- Involved in mediation of inflammation and phagocytosis of antigen-antibody complexes

- They are much less numerous than neutrophils (2-4% of circulating WBCs)

- they have also been associated with the development of allergies

- Basophils

- Contain large, dark blue, histamine containing granules

- Normally, they are the lowest number of circulating WBCs (only 0-1%),

- Play an important role in the escalation of inflammatory responses

Hemostasis

What are the three steps and describe the process of each

- Vascular spasm

- Vasoconstriction (vascular smooth muscle squeezing) of damaged blood vessel

- Formation of a platelet plug

- Positive feedback cycle

Hemostasis (cont)

- Damaged endothelium exposes the blood vessel collagen fibers (important structural proteins) to blood flowing through it

- Platelets stick to exposed collagen fibers via help of the plasma protein Von Willebrand factor

- Platelets swell, become spiked and sticky, and release particular chemical messengers:

- The aforementioned chemical messengers cause more platelets in the area affected to swell, become spiked and sticky, stick to the exposed collagen and release more chemical messengers, which cause the process to continue and amplify

- Usually takes about a minute for the platelets to form a plug large enough to affect blood loss.

- Coagulation

- Reinforces platelet plug with mesh-like arrangement of fibrin threads

- Blood transformed from liquid to gel-like substance (clot) helping to reinforce and seal larger breaks

Blood Transfusion

What is a blood transfusion?

> The process of transferring blood or blood products from one person to another

The CV System

What does the CV system consist of?

> consists of three interrelated components: Blood Heart Blood vessels

Antigens & Antibodies

What are antigens?

> surface identification markers to the immune system

Blood

What type of tissue is blood?

> connective tissue

> Composed of: Plasma (~55%) Formed elements (~45%)

Antigens and Antibodies

What are antibodies?

> Proteins produced by B-cells (immune cells) that are used by the immune system for identification and destruction of foreign objects

Components Of Blood

Components of blood

> Plasma (~55% of whole blood by volume)

What is it mostly? (Plasma)

> 91.5% water and 8.5% solutes

What are the different constituents?

> Water and Solutes

What are plasma proteins and where are most made?

> Specific proteins confined to blood are called plasma proteins

Which are found in the greatest amount (by weight, by number)?

> Albumins, Globulins, Fibrinogen

Antigens and Antibodies

What are the effects of antibodies binding to antigens?

> When antibodies attach to antigens of foreign cells, they cause the foreign cells to clump together and eventually undergo immune system mediated destruction

Formed Elements

What is hemopoiesis?

> Process by which the formed elements of blood develop

Where does it take place in humans?

> From late fetal development to death

Formed Elements (cont)

What 2 main types of stem cells do the pluripotent cells give rise to?

> Myeliod and lymphoid stem cells

Why are the lymphoid stem cells named so?

> their beginning development in the red bone marrow and ending in the lymphoid tissue

Acute Lymphoblastic Leukimia

From what line of blood cells does ALL develop?

> White Blood Cells

Regulation of Hemopoiesis

What is the importance of their discovery and artificial synthesis?

> Laboratory made hemopoietic growth factors have shown great promise in helping reduce some of the side effects of chemotherapy as well as treatment of particular disieases and genetic defficiencies

Blood Groups

Which can donate to and receive from who and why?

> Blood typing for ABO status is done using single drops of blood mixed with different antisera

> Agglutination with an antisera indicates the presence of that antigen on the RBC

Red Blood Cells

What do they specialize in?

> The mature form is highly specialized for oxygen transport

Red Blood Cells

How is it able to do its job (what element is necessary)?

> A Hgb molecule consists of 4 large globin proteins (2 alpha and 2 beta chains), each embedding an iron-containing heme center

> The iron binds oxygen

Each hemoglobin can bind to 4 oxygen molecules.

Abnormalities of Erythropoiesis

What is polycythemia and what can cause it?

> a condition of excess number of RBCs per unit volume

> Hypoxia

Abnormalities of Erythropoiesis

What is iron deficiency anemia and why is it important for women to know of its cause?

> Too few healthy red blood cells due to too little iron in the body

> 20% of all women of childbearing age have some form of iron deficiency anemia

Anemias

How may this affect the health of those with the full phenotype of the disease?

> Sickling decreases the cells' flexibility and results in a variety of complications

Transfusion Reaction

What is the danger in someone receiving mismatched blood?

> Diminished oxygen-carrying capacity

> Diminished blood flow beyond blocked vessels

> Hemoglobin in kidney tubules-renal failure

Heart Location

What is the function of the pericardium?

> The pericardium is the membrane that surrounds and protects the heart and retains its position in the mediastinum

List the layers and properties of each?

> The fibrous pericardium is a very dense and non-flexible connective tissue that helps protect and anchor the heart.

> The inner serous pericardium is subdivided into;

> parietal layer adheres to the outermost fibrous layer

> visceral layer also viewed as the outer surface of the heart wall

Heart Location (cont)

> A thin pericardial fluid lubricates the space between the visceral and parietal pericardium (pericardial cavity).

Cardiac Muscle Tissue

What are they heavily reliant on?

> High dependence on aerobic respiration (needs O2) for ATP production

What can they use to make more fuel?

> Can even use lactic acid from skeletal muscles to make more ATP

How are they connected to, and communicate with, each other

> Cardiac myocytes connect to, and communicate with, adjacent neighboring cells through gap junctions in intercalated discs.

> APs spread to other cardiac myocytes by ion travel through gap junctions

Cardiac Muscle Tissue: Electrophysiology

List electrophys similarities with skeletal muscle

> Contractile cardiac muscle fibers have a stable resting membrane potential – stay at stable negative charge until signaled

> In contractile cardiac muscle fibers, depolarization opens fast voltage-gated Na+ channels in the cell membrane

Cardiac Muscle Tissue: Electrophysiology (cont)

Positive sodium rushes in and causes brief reversal of membrane potential – goes from negative to positive

What is responsible for depolarization phase?

Depolarization is due to Na+ influx through fast voltage-gated Na+ channels

What change in cell functioning does depolarization produce?

Depolarization wave results in opening of slow Ca2+ channels in T-tubule membrane (around peak and early repolarization) - influx of calcium-SR releases Ca2+

Cardiac Conduction

Two important roles of autorhythmic fibers

Formation of the conduction system of the heart

Act as pacemakers within that system.

Action Potential Initiation by Pacemaker Cells

Describe their action potential steps

Pacemaker potential End of repolarization closes voltage-gated K+ channels Special (funny current) channels open and let positive ions enter the cell positive ion flow in moves membrane voltage in a positive direction

Action Potential Initiation by Pacemaker Cells (cont)

Depolarization Once the threshold value is met (AP membrane voltage) Fast voltage-gated Ca2+ channels open Ca2+ influx rising phase of action potential

Repolarization-Slow voltage-gated K+ channels open outflow of K+ greater than Ca2+ inflow as the voltage-gated Ca2+ channels close

The Electrocardiogram

What is an ECG

An ECG is a recording of the electrical changes on the surface of the body resulting from the depolarization and repolarization of the myocardium.

Why is it important clinically?

An ECG recording can help us determine normal from abnormal cardiac activity:

What does each wave and interval represent

P wave - atrial depolarization

P-Q interval - time it takes for the atrial contraction to top-off the ventricles

QRS wave - ventricular depolarization and atrial repolarization

S-T segment - time it takes to empty the ventricles before they repolarize (the T wave

Formed Elements

How are they classified?

Have nuclei and a full complement of other organelles

do not contain the protein Hgb

Shorter life-span compared to RBCs

divided into two groups depending on whether they contain conspicuous chemical-filled cytoplasmic granules (when stained)

Agranulocytes

List the agranulocytes , the role of each, and their relative abundance

Monocytes

Arise from the same immediate precursor cell as the 3 granulocytes (the myeloid stem cell), but no granules

Along with neutrophils, monocytes are the other major group of phagocytic cells.

Constitute only 3-8% of the circulating WBCs

Crucial in the defense against viruses, certain bacterial parasites, fungi, and chronic infections

Differentiate into Macrophages in tissues

Some become “fixed” (localized to a particular tissue) and others become “wandering” (roamers that congregate at sites of infection or inflammation)

Agranulocytes (cont)

Lymphocytes

Do not have granules or phagocytize

The major soldiers in immune system battles

Approximately 20-30% of circulating white cells

Lymphocytes are the cornerstone of the specific immune response

Continuously move between blood and lymphatic tissue

Develop into;T-cells B-cells Natural killer cells

WBC Indies

What does it mean if a type of WBC is present in excess amounts?

In this peripheral blood smear a patient with lymphocytic leukemia has a WBC >150,000 and 90% of the WBCs are cancerous lymphocytes!

Clot Retraction

What is clot retraction and how does it occur?

is the consolidation of the fibrin reinforced clot. As the clot retracts, it pulls the edges of the damaged vessel closer together, decreasing the risk of further damage

Intravascular Clotting

What is intravascular clotting and the define the terms in each

Formation of a clot in an unbroken blood vessel (usually a vein) is called thrombosis.

The clot itself is called a thrombus

Embolism: embolus obstructing a vessel

Intavascular Clotting

Why is this dangerous and list some risk factors

Blocks blood supply to region and can result in tissue death

Risk factors – atherosclerosis, infection, inflammation, slowly flowing blood, or blood stasis from immobility

Anticoagulant Drugs

Identify the anticoagulant drugs in the PPT and their respective mechanisms

Aspirin-Antiprostaglandin that inhibits thromboxane A2 synthesis

Heparin-Helps antithrombin block thrombin formation and activity

Warfarin-Interferes with action of vitamin K in clot formation/Works slower than heparin

Dabigatran-Directly inhibits thrombin

Blood Transfusion

How is whole donated blood processed (separated)?

Almost all donated blood in the U.S. is separated into its various components to make better use of it

Blood

What is hematology and how does blood contribute to homeostasis?

The study of blood, blood forming tissues, and the disorders associated with them

Blood contributes to homeostasis by: Transporting respiratory gasses, nutrients, metabolites, and hormones to and from your body's cells. Helping to regulate body pH and temperature. Providing protection through its clotting mechanisms and immune defenses

Antigens and Antibodies

What are cellular antigens typically made of?

Proteins

Glycolipids

Glycoproteins

Proteolipids

Characteristics of Blood

What is ECF?

extracellular fluid

Plasma volume constitutes roughly 25% of extracellular fluid

Other 75% of ECF is interstitial fluid

Antigens and Antibodies

Can a single antibody bind to any antigen? Why?

No, Each antibody type is very specific for a particular antigen

Components Of Blood

List the three formed elements of blood

Red Blood Cells (RBCs) White Blood Cells (WBCs) Platelets

Human Blood Groups

Know the different blood groups

Types A, B, AB, and O

Acute Myeloid Leukimia

From what line of blood cells does AML develop?

Cancer of the myeloid line of blood cells

Acute Lymphoblastic Leukimia

What characterizes it?

Characterized by the overproduction and accumulation of cancerous, immature white blood cells, known as lymphoblasts.

Acute Lymphoblastic Leukimia

What characterizes it?

Characterized by the overproduction and accumulation of cancerous, immature white blood cells, known as lymphoblasts.

Formed Elements

What is hematocrit?

the % of RBCs per unit blood volume

Human Blood Groups

Which have what antigens?

Type A- A antigen

Type B- B antigen

Type AB- A and B antigens

Type O- Neither A or B antigens

Human Blood Groups

Which can donate to and receive from who and why?

Red Blood Cells

What characteristics about the RBC contribute to this specialization?

Due to the lack of most organelles, the majority of their internal space is available for oxygen transport

Red Blood Cells

Why do RBC's have a limited life span?

mature RBCs lack a nucleus or any protein making instructions

This means they cannot synthesize new components to repair damaged ones

Abnormalities of Erythropoiesis

What is anemia?

lowered oxygen carrying capacity of the blood

Anemias

What is hemorrhagic anemia?

precipitous blood loss, and results in an equal decrease in Hct, Hgb content, and RBC count

Anemias

What are they at increased risk for?

Increased risk of stroke

Human Blood Groups

What is it named after?

Named due to its discovery in the blood of the Rhesus monkey

Human Blood Groups

What does positive and negative designate?

Those with the Rh antigen are said to be Rh+ (positive)

Those without the Rh antigen are Rh- (negative)

The Circulatory System

What is the job of the heart and how does it contribute to homeostasis?

The heart and blood vessels transport water, gases (O2, CO2, N2), proteins, hormones, and waste products throughout the body.

Involved in the regulation of temperature and blood pH.

Also helps facilitate the functions of the immune system.

Layers of The Heart Wall

What are the three layer of the heart wall?What composes each?

The epicardium-the thin, transparent outer layer of the heart wall also called the visceral layer of the serous pericardium.

Layers of The Heart Wall (cont)

The myocardium-the thick middle layer composed of cardiac muscle

The endocardium-a simple squamous epithelial layer (known in the circulatory system as "endothelium").

Cardiac Muscle Tissue

What are the two types of cardiac muscle cells?

Contractile fibers and non-contractile fibers

Properties

Excitable tissue-changes in electrical states that affect cellular activity

Like skeletal muscle, cardiac muscle is striated

Contractile units organized much the same as skeletal

Unlike skeletal muscle, cardiac muscle fibers; Are shorter Can branch Have only one (usually centrally located) nucleus.

Have many mitochondria

Readily switches fuel source for aerobic respiration

Autorhythmicity

What is autorhythmicity?

The self initiated rhythmical electrical activity displayed by the heart

Autorhythmicity (cont)

What does that mean for the heart?

Because heart muscle is autorhythmic, it does not rely on the central nervous system to stimulate a heartbeat

How abundant are autorhythmic fibers?

Approximately 1% of cardiac cells are autorhythmic fibers

Autorhythmicity

What do they not do?

Do not function in contraction

What is special about them?

have specialized features that are essential for normal heart excitation

What do they do for the heart?

Constitute a network called the conducting system

The conducting system is in contact with the contractile cardiac myocytes via gap junctions

These cells are what initiate the heartbeat and help spread the impulse (action potential) rapidly through the heart

Cardiac Conduction: Sequence of Excitation

Describe the pathway of action potential conduction through the heart

Sinoatrial node Atrioventricular node Atrioventricular bundle Right and left bundle branches Subendocardial conducting network (Purkinje fibers

Leukocytes

What is positive chemotaxis?

> Chemicals released by microbes, other WBCs, and inflamed tissues can attract particular WBCs, a phenomenon

Leukocytes

What is phagocytosis and which WBCs are the main active phagocytes?

> the process of engulphing a substance or another cell

> Monocytes and neutrophills are the main active phagocytes in the body

Granulocytes

Leukocyte Movement

What is emigration?

> The process by which WBCs leave the blood stream

WBC Indices

Compare number of circulating WBCs to RBCs

> WBCs are far less numerous than RBCs in the blood

> Normal concentration ~5,000-10,000 cells/microliter

WBC Indices

Why are WBC indices clinically important?

> Shifts in the normal percentages of circulating WBCs will often point towards a bacterial infection (elevated percentage of neutrophils) or a viral infection (elevated percentage of lymphocytes

WBC Indies

What is leukocytosis?

> Increase in WBC count above 11,000 cells/microliter

What is Leukopenia?

> WBC count less than 5,000 cells/microliter

WBC Indices

What is a WBC differential and why is it important?

> To enhance the diagnostic value of a WBC count, the percentages of each of the 5 types of WBCs is determined by using a machine to do a statistical analysis of the blood sample

> Shifts in the normal percentages of circulating WBCs will often point towards a bacterial infection (elevated percentage of neutrophils) or a viral infection (elevated percentage of lymphocytes

Formed Elements

What are platelets, their role, and life span?

> Derived from megakaryocytes that splinter into 2000-3000 fragments

> Short life span (5 – 9 days)

> Form a platelet plug in damaged vessels and release chemicals that promote clotting

Hemostasis

What is hemostasis?

> The sequence of responses that halt bleeding

Describe the importance of this response?

> When blood vessels are damaged or ruptured, the hemostatic response must be quick, localized to the region of damage, and carefully controlled in order to be effective

What does it require?

> Requires various clotting factors, and substances released by platelets and injured tissues Three mechanisms reduce blood loss (Vascular spasm Formation of a platelet plug Blood clotting (coagulation)

Fibrinolysis

What is fibrinolysis, the fibrinolytic system, and why is it important?

> a clot has a tendency to enlarge quickly, creating the potential for impairment of blood flow through undamaged vessels

Fibrinolysis

What enzymes are important in this system and how do they function (what do they affect)?

- Both body tissues and blood contain substances that can transform plasminogen (inactive form made by liver) to plasmin, (the enzyme that actively dissolves clots)

- Antithrombin, blocks the activity of thrombin, can be activated to help slow clot formation

Blood Transfusion

What is serum?

- serum is just plasma without the clotting factors

Characteristics of Blood

List the characteristics of blood

- Blood is more dense and viscous (thicker) than water.

- Has a temperature of ~38 deg C (1 deg C higher than oral or rectal body temp)

- Slightly alkaline

- pH ranging from 7.35 – 7.45

- Changes from dark to bright red depending on oxygen content

- Average blood volume in: Males = 5 to 6 liters (~1.5 gal) Females = 4 to 5 liters (~1.2 gal) Difference mainly due to body size

Antigens and Antibodies

Define agglutinogen and how the term relates to antigens

- Promoters of clumping

- Thus antigens are also called agglutinogens because they can trigger a clumping response from the immune system

Characteristics of Blood

What is ISF and how does it relate to blood?

- Interstitial fluid (ISF)

- Fluid that bathes body tissues

- Constantly renewed by blood

Antigens and Antibodies

What are antibodies also called?

- Antibodies are called agglutinins

Components of Blood

Which is most abundant in blood?

- Red Blood Cells

Acute Myeloid Leukimia

What characterizes it?

- characterized by the rapid growth of abnormal white blood cells that accumulate in the bone marrow and interfere with the production of normal blood cells

Regulation of Hemopoiesis

List and define the hemopoietic growth factors

- Erythropoietin (EPO) – increases the # of RBC precursers (formed in kidneys)

- Thrombopoetin (TPO) – stimulates formation of platelets from megakaryocytes (formed in liver)

- Cytokines – small glycoproteins that regulate the development of different blood cells(formed by red bone marrow cells, leukocytes,

Formed Elements

Why is the bi-concave shape important?

- Allows for high surface area to cell volume, which is optimal for gas exchange Also allows RBCs to deform without rupturing Very important in capillary circulation