وزارة التعليم العالي والبحث العلمي
الجامعة التقنية الشمالية
المعهد التقني الدور

الحقيبة التعليمية

القسم العلمي: الإسعاف الفوري

اسم المقرر: علم وظائف الأعضاء

المرحلة / المستوى: الاول

الفصل الدراسي: الأول

السنة الدراسية: 2023 - 2024

اسم المقرر:	علم وضائف الاعضاء					
القسم:	الإسعاف الفوري					
الكلية:						
المرحلة / المستوى	الاول					
الفصل الدراسي:	الاول					
عدد الساعات الاسبوعية:	نظري	30	عملي	30		
عدد الوحدات الدراسية:	4					
الرمز:	TIDO106					
نوع المادة	نظري		عملي		كلهما	.
هل يتوفر نظير للمقرر في الاقسام الاخرى						
اسم المقرر النظير	/					
القسم	/					
رمز المقرر النظير	/					
معلومات تدريسي المادة						
اسم مدرس (مدرسي) المقرر:	اسماء عبد الحق محمد					
اللقب العلمي:	مدرس مساعد					
سنة الحصول على اللقب	2023					
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عدد سنوات الخبرة (تدريس)	**11** سنة					

الوصف العام للمقرر

1- دراسة وضيفة الأعضاء : فهم كيفية عمل كل عضو في الجسم بشكل فردي وكيفية تفاعله مع أنظمة أخرى.

2- البحث والتطوير: السعي لتطوير وتحسين الأساليب والأدوات لتقييم وعلاج اضطرابات وضائف الأعضاء .

3- تحديد الامراض والاضطرابات : التعرف على الامراض والاضطرابات التي تؤثر على وضائف الأعضاء وتحديد أسبابها واثارها .

الاهداف العامة

- فهم عملية وضائف الأعضاء : دراسة تحليل كيفية عمل كل عضو في الجسم البشري بشكل صحيح وفعال.
- تحسين نوعية الحياة: من خلال تقديم الرعاية الشاملة للمرضى وتحسين قدرتهم الوظيفية .
- التشخيص المبكر للاضطرابات الوظيفية: اكتشاف وتغيير أي تغيرات في وضائف الأعضاء قد تشير الى وجود امراض او اضطرابات صحية .

الأهداف الخاصة

1- البحث والتطوير : تطوير وتحسين الأساليب والتقنيات للفهم وتقييم وضائف الأعضاء بشكل دقيق وفعال .

2- التشخيص المبكر: تطوير أدوات التشخيص للكشف عن اضطرابات وضائف الأعضاء قبل ضهور الاعراض.

3- تحسين العلاج والإدارة: تطوير أساليب علاجية ومتقدمة وشخصية لتحسين وضائف الأعضاء وإدارة الامراض المرتبطة بها.

الأهداف السلوكية او نواتج التعلم

- القدرة على التقييم الدقيق : تطوير مهارات التقييم الدقيق لوظائف الأعضاء باستخدام أساليب متقدمة مثل الاختبارات الوظيفية والتصوير الطبي .
- المشاركة الفعالة في الفريق الطبي: القدرة على التعاون بفعالية مع الأطباء والممرضين والمختصين الاخرين لتحقيق افضل نتائج علاجية للمرضى.
- التفاعل مع المرضى والاسرة بشكل فعال : القدرة على التواصل بفعالية مع المرضى واسرهم وشرح نتائج الاختبارات والتقارير والخطط العلاجية بطريقة يفهمونها .

المتطلبات السابقة

- اذكر أي متطلبات سابقة قد يحتاجها الطالب قبل التسجيل في المقرر، مثل مواد دراسية سابقة أو مهارات معينة.

الأهداف السلوكية او مخرجات التعليم الأساسية		
ت		آلية التقييم
1	تعريف الطلاب بالدم ومكوناته	تقارير، واجبات، امتحانات نظرية شفوية وتحريرية
2	تعريف الطلاب بكريات الدم البيضاء ونسبها الطبيعية	تقارير، واجبات، امتحانات نظرية شفوية وتحريرية
3	تعريف الطلاب بعملية تخثر الدم	تقارير، واجبات، امتحانات نظرية شفوية وتحريرية
4	تعريف الطلاب بانواع فقر الدم	تقارير، واجبات، امتحانات نظرية شفوية وتحريرية

أساليب التدريس (حدد مجموعة متنوعة من أساليب التدريس لتناسب احتياجات الطلاب ومحتوى المقرر)

الاسلوب او الطريقة	مبررات الاختيار
1.المناقشة	
2.الالقاء	
لمحاضرة	
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الفصل الاول من المحتوى العلمي						
عنوان الفصل	الوقت					
التوزيع الزمني	النظري	العملي	العنوان الفرعي	طريقة التدريس	التقنيات	طرق القياس
الأسبوع الأول	2	2	**الدم – مكوناته – مسحة الدم – حجم الدم – كريات الدم الحمراء – عدد كريات الدم الحمراء – شكلها – طريقة إحصائها .**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الأسبوع الثاني	2	2	**كريات الدم البيض – عددها – أنواعها – النسب الطبيعية لكل نوع – عمل كريات الدم البيضاء .**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الأسبوع الثالث	2	2	**تخثر الدم – حامضية الدم – الأقراص الدموية ووظيفتها**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الاسبوع الرابع	2	2	**فقر الدم – أنواع فقر الدم**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الأسبوع الخامس	2	2	**اليرقان – أنواعه – أسباب اليرقان – تحلل كريات الدم الحمراء**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الأسبوع السادس	2	2	**الجهاز القلبي الوعائي – نظرة عامة على تشريح جهاز الدوران – تشريح القلب – صمامات القلب .**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الأسبوع السابع	2	2	**موقع القلب بالنسبة لسطح الجسم الحي – القلب كمضخة – الطرح القلبي .**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الأسبوع الثامن	2	2	**تخطيط القلب – الأصوات القلبية – مناطق الصمامات القلبية – الأصوات الطبيعية .**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الأسبوع التاسع	2	2	**ضغط الدم الشرياني – جريان الدم الصامت – الضغط الجوي – قياس ضغط الدم .**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الأسبوع العاشر	2	2	**العوامل المؤثرة على ضغط الدم – العالي – الواطي – السيطرة المركزية على الأوعية الدموية – قياس ضغط الدم العالي – الواطي.**	محاضرة	سبورة – لابتوب – اجراء التجارب المختبرية	
الأسبوع الحادي	2	2	**الجهاز التنفسي – العضلات التنفسية – الحجاب الحاجز –**	محاضرة	سبورة – لابتوب – اجراء التجارب	

عشر			**وظيفة الحجاب الحاجز بالنسبة للرئتين.**		المختبرية	

المحتوى العلمي

Unit one

Physiology

Human physiology is the science of the mechanical, physical, and biochemical functions of humans in good health, their organs, and the cells of which they are composed. The principal level of focus of physiology is at the level of organs and systems. Most aspects of human physiology, and animal experimentation has provided much of the foundation of physiological knowledge. Anatomy and physiology are closely related fields of study: anatomy, the study of form, and physiology, the study of function,. The word physiology is form Ancient Greek: φύσις, *physis*, "nature, origin"; and -λογία, *-logia*, "study of"

1-1 The blood

Blood is the life-maintaining fluid that circulates through the body's:- Heart. , arteries ,veins , capillaries

The blood consists of a suspension of special cells in a liquid called plasma. In an adult man, the blood is about 1/12th of the body weight and this corresponds to 5-6 liters. Blood consists of 55 % plasma, and 45 % by cells called formed elements.
The blood performs a lot of important functions. By means of the hemoglobin contained in the erythrocytes, it carries oxygen to the tissues and collects the carbon dioxide (CO_2). It also conveys nutritive substances (e.g. amino acids, sugars, mineral salts) and gathers the excreted material which will be eliminated through the renal filter. The blood also carries hormones, enzymes and vitamins. It performs the defense of the organism by mean of the phagocitic activity of the leukocytes, the bactericidal power of the serum and the immune response of which the lymphocytes are the protagonists.

2-1 Functions of blood

1- **Transports :-**

(Dissolved gases (e.g. oxygen, carbon dioxide), waste products of metabolism (e.g. water, urea), hormones ,enzymes Nutrients (such as glucose, amino acids, micro-nutrients (vitamins & minerals), fatty acids, glycerol); Plasma proteins (associated with defense, such as blood-clotting and anti-bodies); Blood cells (incl. white blood cells 'leucocytes', and red blood cells 'erythrocytes and platelets

2- Maintains Body Temperature.

3- Control pH (The pH of blood must remain in the range 6.8 to 7.4, otherwise it begins to damage cells)

4- Removes toxins from the body

(The kidneys filter all of the blood in the body (approx. 8 pints), 36 times every 24 hours. Toxins removed from the blood by the kidneys leave the body in the urine.

(Toxins also leave the body in the form of sweat.)

5- Regulation of Body Fluid Electrolytes

Excess salt is removed from the body in urine, which may contain around 10g salt per day(such as in the cases of people on western diets containing more salt than the body requires

3-1 The plasma

The plasma is a slightly alkaline fluid, with a typical yellowish color. It consists of 90 % water and 10% dry matter. Nine parts of it are made up by organic substances, whereas one part is made up by minerals. These organic substances are composed of (glucose), lipids (cholesterol, triglycerides, phospholipids, lecithin, fats), proteins (globulins, albumins, fibrinogen), glycoproteins, hormones (gonadothropins, erythropoietin, thrombopoietin), amino acids and vitamins. The mineral substances are dissolved in ionic form, that is dissociated into positive and negative ions.

4-1 the blood cells

1- Red blood cells (erythrocytes)

The erythrocytes are the most numerous blood cells i.e. about 4-6 millions/mm^3. They are also called red cells. In man and in all mammals, erythrocytes are devoid of a nucleus and have the shape of a biconcave lens. they have a nucleus. The red cells are rich in hemoglobin, a protein able to bind in a faint manner to oxygen. In the red cells of the mammalians, the lack of nucleus allows more room for hemoglobin and the biconcave shape of these cells raises the surface and cytoplasmic volume ratio. The mean life of erythrocytes is about 120 days. When they come to the end of their life, they are retained by the spleen where they are phagocyted by macrophages.

5-1 Functions of red blood cells

The primary function of red blood cells, or erythrocytes, is to carry oxygen and carbon dioxide. Hemoglobin (Hgb) is an important protein in the red blood cells that carries oxygen from the lungs to all parts of our body.

Test –No. 1

Enumerate the functions of blood

Test – No. 2

What is the main functions of erythrocyte

Unit two

1-2 White blood cells (leukocytes)

Leukocytes, or white cells, are responsible for the defense of the organism. In the blood, they are much less numerous than red cells. The density of the leukocytes in the blood is 5000-7000 /mm^3. Leukocytes divide in two categories: granulocytes and lymphoid cells or agranulocytes. The term granulocyte is due to

the presence of granules in the cytoplasm of these cells. In the different types of granulocytes, the granules are different and help us to distinguish them. In fact, these granules have a different affinity towards neutral, acid or basic stains and give the cytoplasm different colors. So, granulocytes distinguish themselves in neutrophil, eosinophil (or acidophil) and basophil. The lymphoid cells, instead, distinguish themselves in lymphocytes and monocytes. As we will see later, even the shape of the nucleus helps us in the recognition of the leukocytes.

Each type of leukocyte is present in the blood in different proportions:

neutrophil 50 - 70 %
eosinophil 2 - 4 %
basophil 0,5 - 1 %
lymphocyte 20 - 40 %
monocyte 3 - 8 %

2-2 Functions of white blood cells

- The primary function of white blood cells, or leukocytes, is to fight infection. There are several types of white blood cells and each has its own role in fighting bacterial, viral, fungi, and parasitic infections. Types of white blood cells that are most important for helping protect the body from infection and foreign and Help heal wounds not only by fighting infection but also by ingesting matter such as dead cells, tissue debris and old red blood cells.
- Are our protection from foreign bodies that enter the blood stream, such as allergens.

Types of white blood cells include:

A granulocytes

- Lymphocytes.
- Monocytes.

(granulocytes).

- **Eosinophils.**
- **Basophils.**
- **Neutrophils**

1- Neutrophils

are very active in phagocyting bacteria and are present in large amount in the pus of wounds. Unfortunately, these cells are not able to renew the lysosomes used in digesting microbes and dead after having phagocyted a few of them.

2- Eosinophils

attack parasites and phagocyte antigen-antibody complexes

3- Basophil

secrete anti-coagulant and vasodilatory substances as histamines and serotonin. Even if they have a phagocytory capability, their main function is secreting substances which mediate the hypersensitivity reaction

Lymphocytes :- T – lymphocyte B – lymphocyte

are cells which, besides being present in the blood, populate the lymphoid tissues and organs too, as well as the lymph circulating in the lymphatic vessel. The lymphoid organs include thymus, bone marrow ,spleen, lymphoid nodules, palatine tonsils, Peyer's patches and lymphoid tissue of respiratory and gastrointestinal tracts.

Monocytes

are the precursors of macrophages. They are larger blood cells, which after attaining maturity in the bone marrow, enter the blood circulation where they stay for 24-36 hours. Then they migrate into the connective tissue, where they become macrophages and move within the tissues. In the presence of an inflammation site, monocytes quickly migrate from the blood vessel and start an intense phagocytory activity. The role of these cells is not solely in phagocytosis because they have also have an intense secretory activity. They produce substances which have defensive functions such as lysozime, interferons and other substances which modulate the functionality of other cells. Macrophages cooperate in the immune defense. They expose molecules of digested bodies on the membrane and present them to more specialized cells, such as B and T lymphocytes

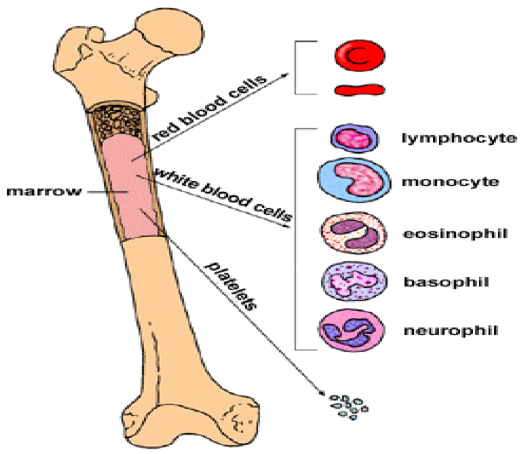
Test- No. 1

Enumerate the leucocytes cells and what is the function of leukocytes cells

<u>unit three</u>

1-3 - Platelets (thrombocytes) - help in blood clotting.

The primary function of platelets, or thrombocytes, is blood clotting. Platelets are much smaller in size than the other blood cells. The normal platelet count is 150,000-350,000 per microliter of blood They group together to form clumps, or a plug, in the hole of a vessel to stop bleeding.



2-3 Blood Clotting

When blood vessels are cut or damaged, the loss of blood from the system must be stopped before shock and possible death occur. This is accomplished by solidification of the blood, a process called coagulation or clotting.

A blood clot consists of

- **a plug of platelets enmeshed in a**
- **network of insoluble fibrin molecules.**

Platelet aggregation and fibrin formation both require the proteolytic enzyme thrombin. Clotting also requires:

- **calcium ions (Ca^{2+})(which is why blood banks use a chelating agent to bind the calcium in donated blood so the blood will not clot in the bag).**
- **about a dozen other protein clotting factors. Most of these circulate in the blood as inactive precursors. They are activated by proteolytic cleavage becoming, in turn, active proteases for other factors in the system.**

3-3 Initiating the Clotting Process

- **Damaged cells display a surface protein called tissue factor (TF)**
- **Tissue factor binds to activated Factor 7.**
- **The TF-7 heterodimer is a protease with two substrates:**
    - **Factor 10 and**
    - **Factor 9**
    - **Let's follow Factor 10 first.**
- **Factor 10 binds and activates Factor 5. This heterodimer is called prothrombinase because it is a protease that converts prothrombin (also known as Factor II) to thrombin.**
- **Thrombin has several different activities. Two of them are:**
    - **proteolytic cleavage of fibrinogen (aka "Factor I") to form:**
        - **soluble molecules of fibrin and a collection of small**
        - **fibrinopeptides**
    - **activation of Factor 13 which forms covalent bonds between the soluble fibrin molecules converting them into an insoluble meshwork — the clot.**

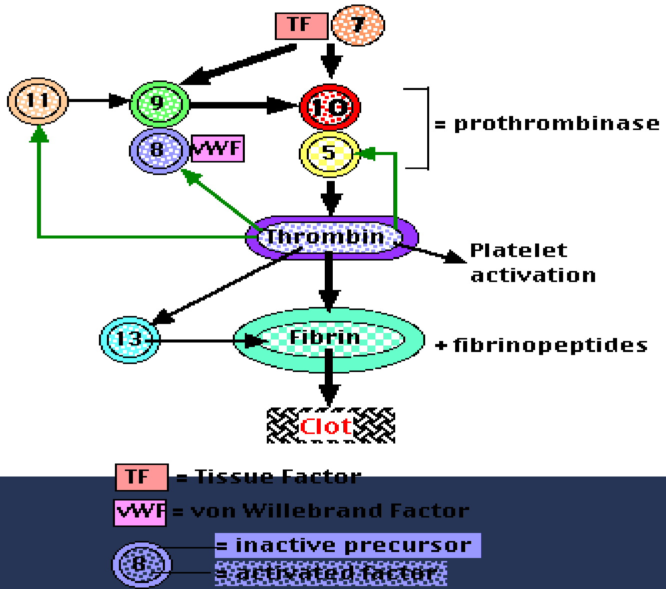
(Thrombin and activated Factors 10 ("Xa") and 11 ("XIa") are serine proteases)

4-3 Amplifying the Clotting Process

The clotting process also has several positive feedback loops which quickly magnify a tiny initial event into what may well be a lifesaving plug to stop bleeding.

- **The TF-7 complex (which started the process) also activates Factor 9.**
  - **Factor 9 binds to Factor 8, a protein that circulates in the blood stabilized by another protein, von Willebrand Factor (vWF).**
  - **This complex activates more Factor 10.**
- **As thrombin is generated, it activates more**
  - **Factor 5**
  - **Factor 8, and**
  - **Factor 11 (all shown above with green arrows).**
- **Factor 11 amplifies the production of activated Factor 9.**

Thus what may have begun as a tiny, localized event rapidly expands into a cascade of activity.



Test No. 1

What is the main functions of platelets

Test No.2

Describe the three basic steps involved in the clotting process

Unit four

1-4 Anticoagulants

An anticoagulant is a drug that helps prevent the clotting (coagulation) of blood. These drugs tend to prevent new clots from forming or an existing clot from enlarging. They don't dissolve a blood clot. Anticoagulants are also given to certain people at risk for forming blood clots, such as those with artificial heart valves or who have atrial fibrillation

A common type of stroke is caused by a blood clot blocking blood flow to the brain. To prevent such clots, anticoagulants are often prescribed for people with conditions such as atrial fibrillation to prevent a first or recurrent stroke.

Heparin and warfarin, a derivative of coumarin, are some examples of anticoagulants

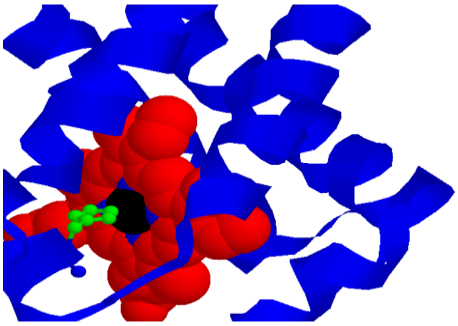
2-4 Hemoglobin

Hemoglobin is the protein that carries oxygen from the lungs to the tissues and carries carbon dioxide from the tissues back to the lungs. In order to function most efficiently, hemoglobin needs to bind to oxygen tightly in the oxygen-rich atmosphere of the lungs and be able to release oxygen rapidly in the relatively oxygen-poor environment of the tissues. It does this in a most elegant and intricately coordinated way. The story of hemoglobin is the

prototype example of the relationship between structure and function of a protein molecules

3-4 *Hemoglobin Structure*

A hemoglobin molecule consists of four polypeptide chains: two alpha chains, each with 141 amino acids and two beta chains, each with 146 amino acids. The protein portion of each of these chains is called "globin". The a and b globin chains are very similar in structure. In this case, a and b refer to the two types of globin. Students often confuse this with the concept of a helix and b sheet secondary structures. But, in fact, both the a and b globin chains contain primarily a helix secondary structure with no b sheets



A heme group is a flat ring molecule containing carbon, nitrogen and hydrogen atoms, with a single Fe^{2+} ion at the center. Without the iron, the ring is called a porphyrin. In a heme molecule, the iron is held within the flat plane by four nitrogen ligands from the porphyrin ring. The iron ion makes a fifth bond to a histidine side chain from one of the helices that form the heme pocket. This fifth coordination bond is to histidine 87 in the human chain and

histidine 92 in the human □ chain. Both histidine residues are part of the F helix in each globin chain.

4-4 The Bohr Effect

The ability of hemoglobin to release oxygen, is affected by pH, CO_2 and by the differences in the oxygen-rich environment of the lungs and the oxygen-poor environment of the tissues. The pH in the tissues is considerably lower (more acidic) than in the lungs. Protons are generated from the reaction between carbon dioxide and water to form bicarbonate:

$CO_2 + H_20$ ----------------> $HCO_3^- + H^+$

This increased acidity serves a twofold purpose. First, protons lower the affinity of hemoglobin for oxygen, allowing easier release into the tissues. As all four oxygens are released, hemoglobin binds to two protons. This helps to maintain equilibrium towards the right side of the equation. This is known as the Bohr effect, and is vital in the removal of carbon dioxide as waste because CO_2 is insoluble in the bloodstream. The bicarbonate ion is much more soluble, and can thereby be transported back to the lungs after being bound to hemoglobin. If hemoglobin couldn't absorb the excess protons, the equilibrium would shift to the left, and carbon dioxide couldn't be removed.

In the lungs, this effect works in the reverse direction. In the presence of the high oxygen concentration in the lungs, the proton affinity decreases. As protons are shed, the reaction is driven to the left, and CO_2 forms as an insoluble gas to be expelled from the lungs. The proton poor hemoglobin now has a greater affinity for oxygen, and the cycle continue

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Test –No.1

Define hemoglobin and describe the structure of hemoglobin

Test No. 2

Define anticoagulant and give me two example of it

Unit five

1-5 Blood Groups

Blood groups are created by molecules present on the surface of red blood cells (and often on other cells as well).

2-5 *The ABO Blood Groups*

The ABO blood groups were the first to be discovered (in 1900) and are the most important in assuring safe blood transfusions.

The table shows the four ABO phenotypes ("blood groups") present in the human population and the genotypes that give rise to them.

Blood Group	Antigens on RBCs	Antibodies in Serum	Genotypes
A	A	Anti-B	*AA* or *AO*
B	B	Anti-A	*BB* or *BO*
AB	A and B	Neither	*AB*
O	Neither	Anti-A and Anti-B	*OO*

When red blood cells carrying one or both antigens are exposed to the corresponding antibodies, they agglutinate; that is, clump

together. People usually have antibodies against those red cell antigens that they lack.

The antigens in the ABO system are O-linked glycoproteins with their sugar residues exposed at the cell surface. The terminal sugar determines whether the antigen is A or B.

The critical principle to be followed is that transfused blood must not contain red cells that the recipient's antibodies can clump. Although theoretically it is possible to transfuse group O blood into any recipient, the antibodies in the donated plasma can damage the recipient's red cells. Thus, when possible, transfusions should be done with exactly-matched blood. than "self".

3-5 The *Rh System*

Rh antigens are transmembrane proteins with loops exposed at the surface of red blood cells. They appear to be used for the transport of carbon dioxide and/or ammonia across the plasma membrane. They are named for the rhesus monkey in which they were first discovered.

There are a number of Rh antigens. Red cells that are "Rh positive" express the one designated D. About 15% of the population have no RhD antigens and thus are "Rh negative".

The major importance of the Rh system for human health is to avoid the danger of RhD incompatibility between mother and fetus.

During birth, there is often a leakage of the baby's red blood cells into the mother's circulation. If the baby is Rh positive (having inherited the trait from its father) and the mother Rh-negative, these red cells will cause her to develop antibodies against the RhD antigen. The antibodies, usually of the IgG class, do not cause any problems for that child, but can cross the placenta and attack the red cells of a subsequent Rh^+ fetus. This destroys the red cells producing anemia and jaundice.

The disease, called erythroblastosis fetalis or hemolytic disease of the newborn, may be so severe as to kill the fetus or even the newborn infant. It is an example of an antibody-mediated cytotoxicity disorder.

Other examples of antibody-mediated cytotoxicity disorders.

Although certain other red cell antigens (in addition to Rh) sometimes cause problems for a fetus, an ABO incompatibility does not. Why is an Rh incompatibility so dangerous when ABO incompatibility is not?

It turns out that most anti-A or anti-B antibodies are of the IgM class and these do not cross the placenta. In fact, an Rh^-/type O mother carrying an Rh^+/type A, B, or AB fetus is resistant to sensitization to the Rh antigen. Presumably her anti-A and anti-B antibodies destroy any fetal cells that enter her blood before they can elicit anti-Rh antibodies in her.

This phenomenon has led to an extremely effective preventive measure to avoid Rh sensitization. Shortly after each birth of an Rh^+ baby, the mother is given an injection of anti-Rh antibodies. The preparation is called Rh immune globulin (RhIG) or Rhogam. These passively acquired antibodies destroy any fetal cells that got into her circulation before they can elicit an active immune response in her.

Rh immune globulin came into common use in the United States in 1968, and within a decade the incidence of Rh hemolytic disease became very

Test No. 1

What are the types of blood groups in human

Test No. 2

What is the Rh factor

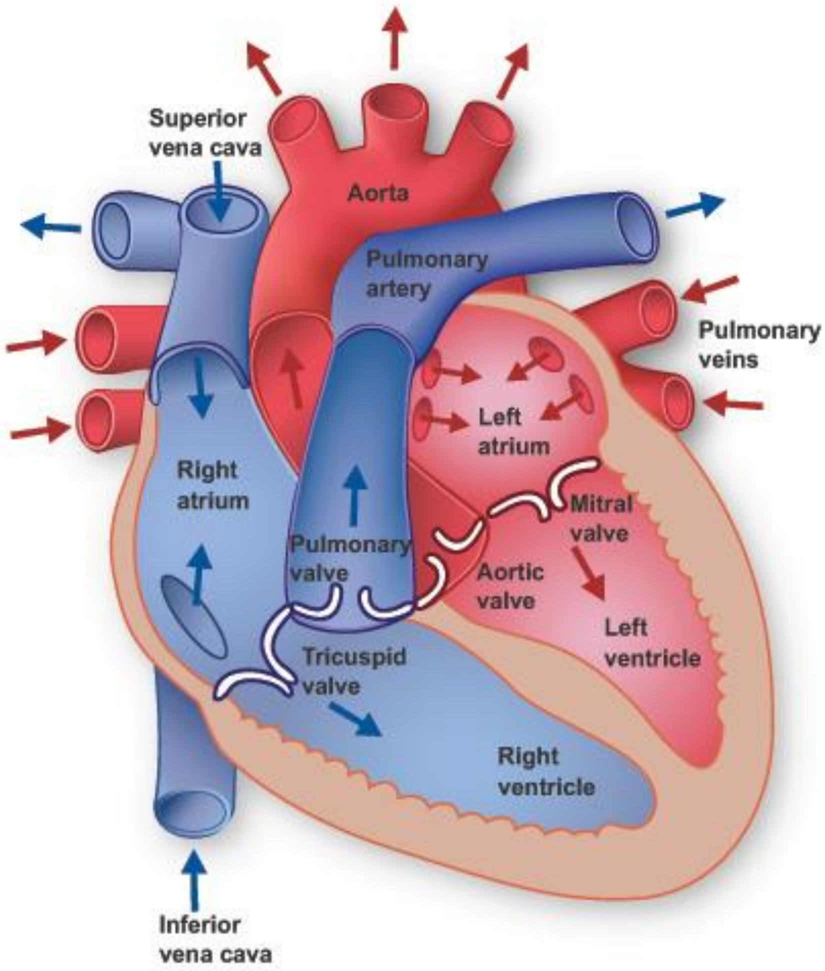
Unit sex

1-6 Cardiovascular system

The main components of the human cardiovascular system are the heart and the blood vessels. It includes: the pulmonary circulation, a "loop" through the lungs where blood is oxygenated; and the systemic circulation, a "loop" through the rest of the body to provide oxygenated blood. An average adult contains five to six quarts (roughly 4.7 to 5.7 liters) of blood, which consists of plasma, red blood cells, white blood cells, and platelets. Also, the digestive system works with the circulatory system to provide the nutrients the system needs to keep the heart pumping

2-6 The heart

The heart weighs between 7 and 15 ounces (200 to 425 grams) and is a little larger than the size of your fist. By the end of a long life, a person's heart may have beat (expanded and contracted) more than 3.5 billion times. In fact, each day, the average heart beats 100,000 times, pumping about 2,000 gallons (7,571 liters) of blood.



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Your heart is located between your lungs in the middle of your chest, behind

and slightly to the left of your breastbone (sternum). A double-layered and slightly to the left of your breastbone (sternum). A double-layered membrane called the pericardium surrounds your heart like a sac. The outer layer of the pericardium surrounds the roots of your heart's major blood vessels and is attached by ligaments to your spinal column, diaphragm, and other parts of your body. The inner layer of the pericardium is attached to the heart muscle. A coating of fluid separates the two layers of membrane, letting the heart move as it beats, yet still be attached to your body.

Your heart has 4 chambers. The upper chambers are called the left and right atria, and the lower chambers are called the left and right ventricles. A wall of muscle called the septum separates the left and right atria and the left and right ventricles. The left ventricle is the largest and strongest chamber in your heart. The left ventricle's chamber walls are only about a half-inch thick, but they have enough force to push blood through the aortic valve and into your body.

3-6 The Heart Valves :-

Four types of valves regulate blood flow through your heart:

- **The tricuspid valve regulates blood flow between the right atrium and right ventricle.**
- **The pulmonary valve controls blood flow from the right ventricle into the pulmonary arteries, which carry blood to your lungs to pick up oxygen.**
- **The mitral valve lets oxygen-rich blood from your lungs pass from the left atrium into the left ventricle.**
- **The aortic valve opens the way for oxygen-rich blood to pass from the left ventricle into the aorta, your body's largest artery, where it is delivered to the rest of your body.**

4-6 The Conduction System

Electrical impulses from your heart muscle (the myocardium) cause your heart to contract. This electrical signal begins in the sinoatrial (SA) node, located at the top of the right atrium. The SA node is sometimes called the heart's "natural pacemaker." An electrical impulse from this natural pacemaker travels through the muscle fibers of the atria and ventricles, causing them to contract. Although the SA node sends electrical impulses at a

certain rate, your heart rate may still change depending on physical demands, stress, or hormonal factors

Test No.1

Name the valves of the heart and explain the purpose of each valves

Unit seven

1-7 Blood vessels

A VEINS (proprieties of veins)

1- **Veins function to return poorly oxygenated blood to the heart.**
2- **veins tubes collapse when their lumen are not filled with blood.**
3- **The thick, outer-most layer of a vein is made of collagen, wrapped in bands of smooth muscle while the interior is lined with epithelial cells called intima.**
4- **Most veins have one-way flaps called venous valves that prevent blood from flowing back and pooling in the lower extremities due to the effects of gravity.**
5- **The precise location of veins is much more variable from person to person than that of arteries.**

B- ARTERIES (proprieties of arteries)

1- Arteries are blood vessels that carry blood away from the

heart (as opposed to veins, blood vessels carrying blood toward the heart). All arteries, with the exception of the pulmonary and umbilical arteries, carry oxygenated blood.

2- The artery is has three layers: A muscular middle which is very elastic and strong, an outer layer of tissue, and an inner layer of smooth epithelial cells that allow the blood to flow easily.

3- The muscular wall of the artery actually helps the heart to pump blood. When your heart beats the artery expands with blood. Because the artery keeps pace with the heart you can actually measure how many heart beats per minute you have by counting the contractions of the artery (pulse rate)

4- Arteries also deliver oxygen rich blood to the capillaries where the actual exchange of carbon dioxide and oxygen happen.

C- <u>Capillaries</u> (proprieties of capillaries)

1. **Capillaries are very thin, fragile blood vessels that receive oxygen-rich blood from arteries, exchange oxygen and carbon dioxide and then deliver the waste-rich blood to the veins.**
2. **Capillaries are only one epithelial cell thick and blood can only flow through them in a single file. The red blood cells inside the capillary release their oxygen, which passes through the wall and into the surrounding tissue. The tissue releases its waste products, e.g. carbon dioxide, which pass through the wall and into the red blood cells. The exchange occurs and the waste blood is carried back to the heart and lungs through the veins.**

2-7 <u>THE BLOOD CIRCULATORY SYSTEM</u>

There are three types of blood circulatory system, two of which (systemic circulation and pulmonary circulation) depend on a pump, the heart, to push the blood around. The third type of circulation is known as a portal system. These are specialised channels that connect one capillary bed site to another but do not depend directly on a central pump. The largest of these in the

human is the hepatic portal system which connects the intestines to the liver.

3-7 <u>The systemic circulation</u>

transfers oxygenated blood from a central pump (the heart) to all of the body tissues (systemic arterial system) and returns deoxygenated blood with a high carbon dioxide content from the tissues to the central pump (systemic venous system).

As briefly mentioned above the systemic circulation supplies all the body tissues, and is where exchange of nutrients and products of metabolism occurs. All the blood for the systemic circulation leaves the left side of the heart via the aorta.

This large artery then divides into smaller arteries and blood is delivered to all tissues and organs. These arteries divide into smaller and smaller vessels each with its own characteristic structure and function. The smallest branches are called arterioles.

The arterioles themselves branch into a number of very small thin vessels, the capillaries, and it is here that the exchange of gases, nutrients and waste products occurs.

Exchange occurs by diffusion of substances down concentration and pressure gradients.

The capillaries then unite to form larger vessels, venules, which in turn unite to form fewer and larger vessels, known as veins.

The veins from different organs and tissues unite to form two large veins. The inferior vena cava (from the lower portion of the body) and the superior vena cava (from the head and arms), which return blood to the right side of the heart. Thus there are a number of parallel circuits within the systemic circulation.

4-7<u>The pulmonary circulation</u>

is where oxygen and carbon dioxide exchange between the blood and alveolar air occurs. The blood leaves the right side of the

heart through a single artery, the pulmonary artery, which divides into two - one branch supplying each lung. Within the lung, the arteries divide, ultimately forming arterioles and capillaries; venules and veins return blood to the left side of the heart.

5-7Portal circulation:-

Normally there is only one capillary bed for each branch of a circuit; however, there are a few instances where there are two capillary beds, one after each other, in series. These are known as portal systems or portal circulations. One example of this is in the liver. Part of the blood supply to the liver is venous blood coming directly from the gastrointestinal tract and spleen via the hepatic portal vein. This arrangement enables the digested and absorbed substances from the gut to be transported directly to the liver, where many of the body's metabolic requirements are synthesised. Thus there are two micro-circulations in series, one in the gut and the other in the liver.

The force required to move the blood through the blood vessels in the two circulations is provided by the heart, which functions as two pumps, the left side of the heart supplying the systemic circulation and the right side the pulmonary circulation.

The systemic circulation is much larger than the pulmonary circulation and thus the force generated by the left side of the heart is much greater than that of the right side of the heart. However, as the circulatory system is a closed system, the volume of blood pumped through the pulmonary circulation in a given period of time must equal the volume pumped through the systemic circulation - that is, the right and left sides of the heart must pump the same amount of blood. In a normal resting adult, the average volume of blood pumped simultaneously is approximately 5 liters per min. As there are approximately 5 liters of blood in an adult, this means that the blood circulates around the body approximately once every minute. During heavy work or

exercise, the volume of blood pumped by the heart can increase up to 25 liters per min .

Test No. 1

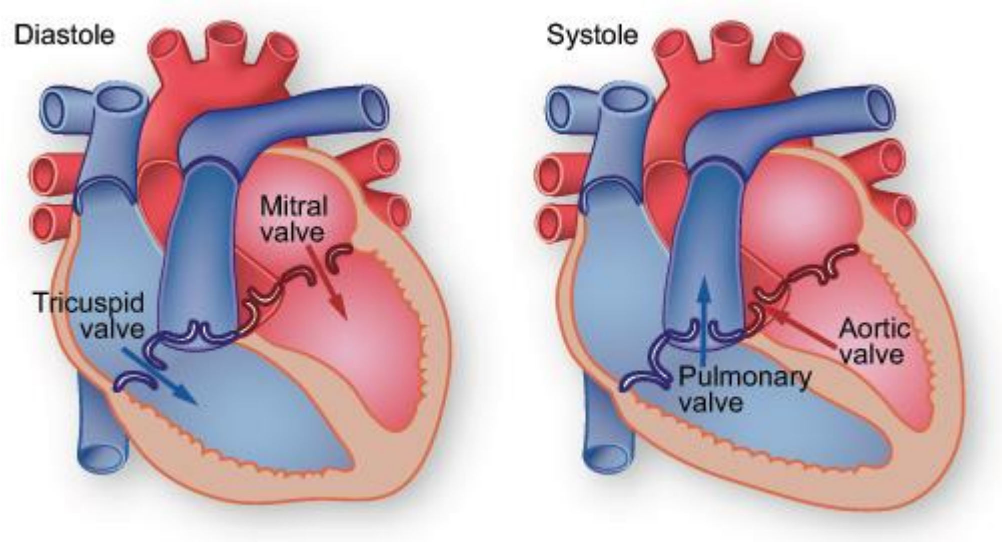
Enumerate the blood vessels and distinguish between them in properties

Test No. 2

How many blood circulations in human body Explain one

Unit eight

1-8 Heart beat



A heartbeat is a two-part pumping action that takes about a second. As blood collects in the upper chambers (the right and left atria), the heart's natural pacemaker (the SA node) sends out an electrical signal that causes the atria to contract. This contraction pushes blood through the tricuspid and mitral valves into the resting lower chambers (the right and left ventricles). This part of the two-part pumping phase (the longer of the two) is called diastole.

The second part of the pumping phase begins when the ventricles are full of blood. The electrical signals from the SA node travel along a pathway of cells to the ventricles, causing them to contract. This is called systole. As the tricuspid and mitral valves shut tight to prevent a back flow of blood, the pulmonary and aortic valves are pushed open. While blood is pushed from the right ventricle into the lungs to pick up oxygen, oxygen-rich blood flows from the left ventricle to the heart and other parts of the body.

After blood moves into the pulmonary artery and the aorta, the ventricles relax, and the pulmonary and aortic valves close. The

lower pressure in the ventricles causes the tricuspid and mitral valves to open, and the cycle begins again. This series of contractions is repeated over and over again, increasing during times of exertion and decreasing while you are at rest. The heart normally beats about 60 to 80 times a minute when you are at rest, but this can vary. As you get older, your resting heart rate rises. Also, it is usually lower in people who are physically fit.

2-8 blood pressure

Blood pressure is the pressure of the blood against the walls of the arteries.

Blood pressure results from two forces. One is created by the heart as it pumps blood into the arteries and through the circulatory system. The other is the force of the arteries as they resist the blood flow.

What do blood pressure numbers indicate?

- **The higher (systolic) number represents the pressure while the heart contracts to pump blood to the body.**
- **The lower (diastolic) number represents the pressure when the heart relaxes between beats.**

Blood pressure changes during the day. It is lowest as you sleep and rises when you get up. It also can rise when you are excited, nervous, or active.

Still, for most of your waking hours, your blood pressure stays pretty much the same when you are sitting or standing still. That level should be lower than 120/80. When the level stays high, 140/90 or higher, you have high blood pressure. With high blood pressure, the heart works harder, your arteries take a beating, and your chances of a stroke, heart attack, and kidney problems are greater.

What causes it?

In many people with high blood pressure, a single specific cause is not known. This is called essential or primary high blood pressure. Research is continuing to find causes.

In some people, high blood pressure is the result of another medical problem or medication. When the cause is known, this is called secondary high blood pressure.

What is high blood pressure?

A blood pressure of 140/90 or higher is considered high blood pressure. Both numbers are important. If one or both numbers are usually high, you have high blood pressure. If you are being treated for high blood pressure, you still have high blood pressure even if you have repeated readings in the normal range.

3-8 Factors Affect Blood Pressure Readings?

There a number of factors that will temporarily affect blood pressure. Most are short-lived and will affect your blood pressure temporarily and then blood pressure will return to resting blood pressure.

Short-lived factors that may cause changes in blood pressure, both raising and lowering, include:

- **Asleep or awake – usually lower when sleeping**
- **Body position - lying down, sitting or standing**
- **Emotional state - such as stress and anger or being relaxed**
- **Activity level - from not moving to extreme exertion**
- **Temperature – blood pressure will tend to go up when you are cold**
- **White coat hypertension – blood pressure increases in a medical setting**

- **Sleep apnea - pauses in breathing while sleeping raise blood pressure**
- **Smoking – increases blood pressure**
- **Caffeine – increases blood pressure**
- **Alcohol – increases blood pressure**

Of the above list, sleep apnea, smoking, alcoholism and chronic stress are the major factors that can, over extended periods of time, cause resting blood pressure to slowly increase due to the impact they have on the body.

There are two levels of high blood pressure: Stage 1 and Stage 2 (see the chart below).

Categories for Blood Pressure Levels in Adults*
(In mmHg, millimeters of mercury)

Category	Systolic (Top number)	Diastolic (Bottom number)
Normal	Less than 120	Less than 80
Prehypertension	120-139	80-89
High Blood Pressure	Systolic	Diastolic
Stage 1	140-159	90-99

Stage 2	160 or higher	100 or higher

*** For adults 18 and older who:**

- **Are not on medicine for high blood pressure**
- **Are not having a short-term serious illness**
- **Do not have other conditions such as diabetes and kidney disease**

Note: When systolic and diastolic blood pressures fall into different categories, the higher category should be used to classify blood pressure level. For example, 160/80 would be stage 2 high blood pressure.
There is an exception to the above definition of high blood pressure. A blood pressure of 130/80 or higher is considered high blood pressure in persons with diabetes and chronic kidney disease

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Test No. 1

Define blood pressure and what is the normal rate of blood pressure

Test No. 2

Enumerate the factor that effecting on blood pressure reading

Unit nine

Respiratory system

The primary function of the respiratory system is the supply of oxygen to the blood so this in turn delivers oxygen to all parts of the body. The respiratory system does this while breathing is taking place. During the process of breathing we inhale oxygen and exhale carbon dioxide. This exchange of gases takes place at the alveoli. The average adult's lungs contain about 600 million of these spongy, air-filled sacs that are surrounded by capillaries. The inhaled oxygen passes into the alveoli and then diffuses through the capillaries into the arterial blood. Meanwhile, the waste-rich blood from the veins releases its carbon dioxide into the alveoli. The carbon dioxide follows the same path out of the lungs when you exhale.

1-9 the principle functions of the respiratory system are:

- **Ventilate the lungs**
- **Extract oxygen from the air and transfer it to the bloodstream**
- **Excrete carbon dioxide and water vapour**
- **Maintain the acid base of the blood**

inspired Air

This contains approx:

- **79% nitrogen**
- **20% O_2**
- **0.04% CO_2**
- **Water vapour/Trace Gases**

Expired Air

This contains approx:

- **79% nitrogen**
- **16% O_2**
- **4% CO_2**
- **Water vapour/Trace Gases**

2-9 Structure of the respiratory System

Respiration takes place with the aid of the mouth, nose, trachea, lungs, diaphragm and intercostal muscles . Oxygen enters the respiratory system through the mouth and the nose. The oxygen then passes through the larynx and the trachea. In the chest cavity, the trachea splits into two bronchi. Each bronchus then divides again forming the bronchial tubes. The bronchial tubes lead directly into the lungs where they divide into many smaller tubes which connect to tiny sacs called alveoli.

1- The lungs

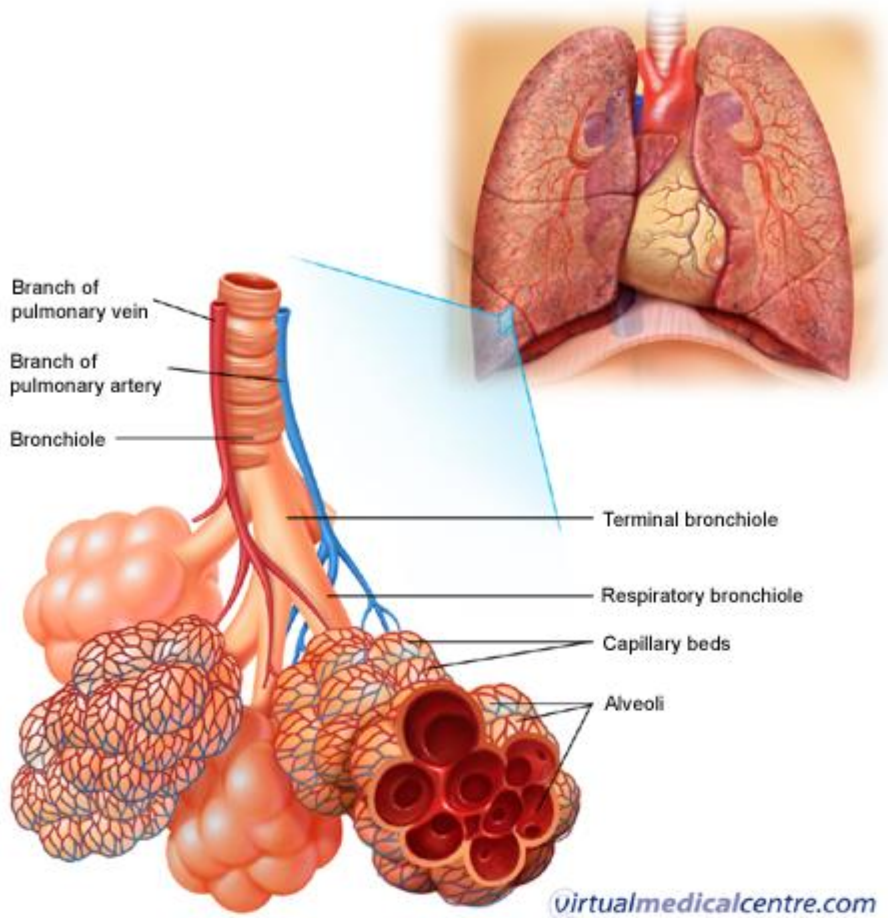
Structure

The lungs are paired, cone-shaped organs which take up most of the space in our chests, along with the heart. Their role is to take oxygen into the body, which we need for our cells to live and function properly, and to help us get rid of carbon dioxide, which is a waste product. We each have two lungs, a left lung and a right lung. These are divided up into 'lobes', or big sections of tissue separated by 'fissures' or dividers. The right lung has three lobes but the left lung has only two, because the heart takes up some of the space in the left side of our chest. The lungs can also be divided up into even smaller portions, called 'bronchopulmonary segments'.

These are pyramidal-shaped areas which are also separated from each other by membranes. There are about 10 of them in each lung. Each segment receives its own blood supply and air supply.

3-9 How they work

Air enters your lungs through a system of pipes called the bronchi. These pipes start from the bottom of the trachea as the left and right bronchi and branch many times throughout the lungs, until they eventually form little thin-walled air sacs or bubbles, known as the alveoli. The alveoli are where the important work of gas exchange takes place between the air and your blood. Covering each alveolus is a whole network of little blood vessel called capillaries, which are very small branches of the pulmonary arteries. It is important that the air in the alveoli and the blood in the capillaries are very close together, so that oxygen and carbon dioxide can move (or diffuse) between them. So, when you breathe in, air comes down the trachea and through the bronchi into the alveoli. This fresh air has lots of oxygen in it, and some of this oxygen will travel across the walls of the alveoli into your bloodstream. Travelling in the opposite direction is carbon dioxide, which crosses from the blood in the capillaries into the air in the alveoli and is then breathed out. In this way, you bring in to your body the oxygen that you need to live, and get rid of the waste product carbon dioxide.



4-9 Blood Supply

The lungs are very vascular organs, meaning they receive a very large blood supply. This is because the pulmonary arteries, which supply the lungs, come directly from the right side of your heart. They carry blood which is low in oxygen and high in carbon dioxide into your lungs so that the carbon dioxide can be blown off, and more oxygen can be absorbed into the bloodstream. The newly oxygen-rich blood then travels back through the paired pulmonary veins into the left side of your heart. From there, it is pumped all around your body to supply oxygen to cells and organs.

5-9 Functions of the lungs

In addition to their function in respiration, the lungs also:

- **alter the pH of blood by facilitating alterations in the partial pressure of carbon dioxide**

- filter out small blood clots formed in veins
- filter out gas micro-bubbles occurring in the venous blood stream such as those created after scuba diving during decompression. influence the concentration of some biologic substances and drugs used in medicine in blood
- convert angiotensin I to angiotensin II by the action of angiotensin-converting enzyme
- may serve as a layer of soft, shock-absorbent protection for the heart, which the lungs flank and nearly enclose.
- Media: Immunoglobulin-A is secreted in the bronchial secretion and protects against respiratory infections.
- maintain sterility by producing mucus containing antimicrobial compounds.] Mucus contains glycoproteins, eg mucins, lactoferrin lysozyme, lactoperoxidase. We find also on the epithelium Dual oxidase proteins generating hydrogen peroxidde, useful for hypothiocyanite endogenous antimicrobial synthesis. Function not in place in cystic fibrosis patient lungs.
- Ciliary escalator action is an important defence system against air-borne infection. The dust particles and bacteria in the inhaled air are caught in the mucous layer present at the mucosal surface of respiratory passages and are moved up towards pharynx by the rhythmic upward beating action of the cilia

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Test No. 1

Enumerate the functions of the lungs

Test No. 2

Comber between inspiration and expiration process

Test No. 3

List the respiratory volume

Note :- this test involved unit(9,10& 11)

Unit ten

1-10 conducting air ways

1- Nose: • Olfaction (smelling)
• Assists in producing sound
• Warming and Humidifying. Highly vascularized mucus membrane that warms and humidifies inspired air. Without this function the trachea can become dry.
• Upper one-third of the nasal cavity is lined with olfactory epithelium the lower two-thirds are lined with pseudostratified ciliated columnar epithelium.
• All the way through the respiratory tract there are numerous mucous secreting goblet cells with microvilli on the surface.
• Cilia plays an important role in propelling mucous and trapped particles in to the pharynx where it is swallowed or spat out.

2- Pharynx:
• Extends from the base of the skull to the inferior border of the cricoids cartilage
• Continuous interiorly with the trachea and posterior with the esophagus
• Divided into 3 parts; Nasopharynx, Or pharynx, Laryngopharynx.
• Oro and Laryngopharynx are part of the respiratory and alimentary tract and are lined with non-keratinized stratified squamous (NKSS)

3- Larynx:
• Inferior end continuous with the trachea. Superior end attached to the hyoid bone and lies below the epiglottis
• Protects the trachea from foreign objects and particles.
• Assists in warming and humidifying incoming air

• Made of cartilaginous material
• The larynx is lined with NKSS epithelium as well as pseudostratified ciliated columnar epithelium
• Includes; Epiglottis, Thyroid, Arytenoids and Cricoids cartilages
• Vocal cords are housed in this area. Air rushing past these cords cause them to vibrate thus making sound

4- <u>Trachea:</u>

• 10cm in length, 2.5cm in diameter and constructed of incomplete C-shaped hyaline cartilage. Rings are completed posteriorly by the trachealis muscle
• Extends from the larynx to the carina; level with 4th and 5th thoracic vertebra

5- <u>Bronchi:</u>

• Primary bronchi is inferior to the carina; bifurcation of the trachea.
• The bronchi are similar in structure to that of the trachea and are lined with ciliated columnar epithelium. As the tubes become smaller the cartilages become irregular and also become smaller until the tubes get to 1mm, this is when the cartilage disappears. As there is no cartilage the smooth muscle becomes thicker.

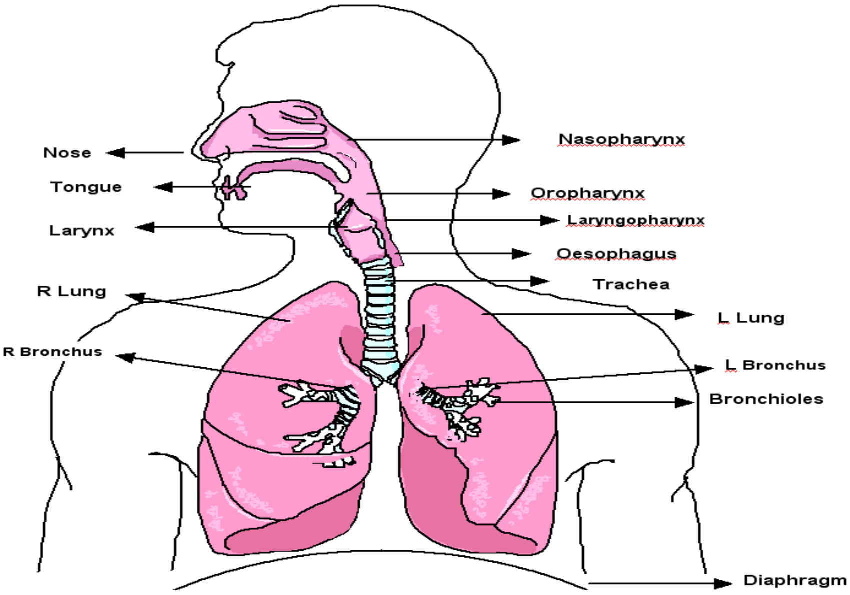
6- <u>Bronchioles:</u>

• No cartilage as the smooth muscle is thicker to help maintain the structure.
• The smooth muscle is responsive to autonomic nerve stimulation
• The internal walls are lined with ciliated columnar mucous membrane but as the walls extend towards the distal bronchiole this membranous layer changes to non-ciliated cuboidal-shaped cells.

7- <u>Terminal Bronchioles:</u>

• Split into 2 or more respiratory bronchioles
• Thinner walls and are lined with ciliated columnar epithelium.
• Do not contain any goblet cells.

• **Increased numbers of clara cells that line the lumen and secrete an agent similar to surfactant**



Unit eleven

1-11 breathing

Air from the atmosphere passes through the conducting airway until it reaches the alveoli. The walls of the alveoli are only one cell thick and this is called the respiratory surface, which is about 70 square meters, where the exchange of gases takes place. Around the alveoli are microscopic capillaries that bring carbon dioxide from the heart via pulmonary artery and delivers oxygen back to the heart via the pulmonary vein. Gas exchange happens when there is a difference in partial pressure at the semi-permeable membrane of the alveoli (diffusion). The diffusion occurs when the higher concentration of a gas moves to the lower concentration until equilibrium is achieved

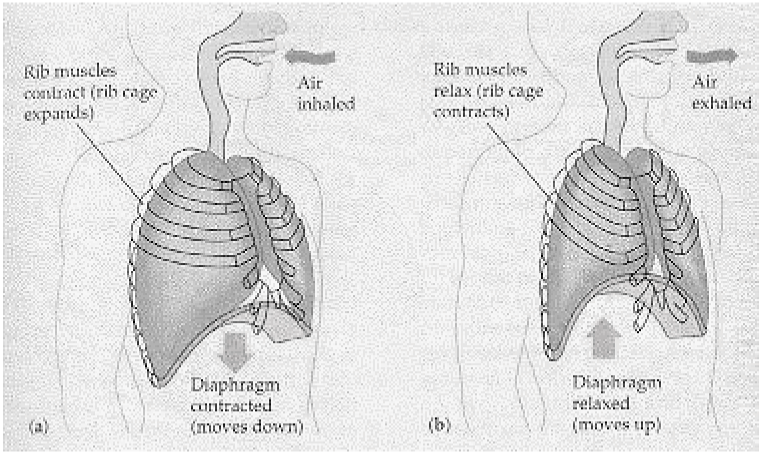
Partial Pressure of Gases			
Gas	Alveolar	Deoxygenated Blood	Oxygenated Blood
O2	105 mmHg	40 mmHg	100 mmHg
CO2	40 mmHg	44 mmHg	40 mmHg

Using the table above, we can see that oxygenated blood from the alveolar will diffuse across the semi-permeable membrane and replace the lower concentration of 02 in the deoxygenated blood. The higher concentration of C02 will diffuse in the same way. This is because Dalton's law states 'each gas exerts its own pressure in proportion to it's concentration in a mixture'. Inhaled 02 has a higher percentage than exhaled 02, its pressure is higher at 100mmHg compared to the 40mmHg of lower percentage from the deoxygenated blood. The reverse of this applies to the C02 because the percentage breathed in is lower than that which is exhaled.

2-11 inspiration and expiration process

- **Inspiration- Diaphragm and intercostals muscles contract. The diaphragm moves downwards. The intercostals muscles make the rib cage move upwards. These two processes increase the volume of the thoracic cavity and also reduces the air pressure to below atmospheric pressure allowing air to rush into the airways then into the alveoli.**

- **Expiration is the opposite of inspiration as in the diaphragm and intercostals muscles relax, this allows the diaphragm to move upwards and the intercostals muscles let the rib cage relax to its resting state. The volume within the thoracic cavity now decreases. This decrease in volume now causes an increase in pressure above atmospheric pressure which forces air out up the airway .**



3-11 <u>Central Control</u>

Breathing is clearly an involuntary process (you don't have to think about it), and like many involuntary processes (such as heart rate) it is controlled by a region of the brain called the medulla. The medulla and its nerves are part of the autonomic nervous system (i.e. involuntary). The region of the medulla that controls breathing is called the respiratory centre. The main centers are the apneustic centre, which enhances inspiration, and the pneumotaxic centre, which terminates inspiration.

The respiratory centre transmits regular nerve impulses to the diaphragm and intercostal muscles to cause inhalation. Stretch receptors in the alveoli and bronchioles detect inhalation and send inhibitory signals to the respiratory centre to cause exhalation. This negative feedback system in continuous and prevents damage to the lungs

Ventilation is also under voluntary control from the cortex, the voluntary part of the brain. This allows you to hold your breath or blow out candles, but it can be overruled by the autonomic system in the event of danger. For example if you hold your breath for a long time, the carbon dioxide concentration in the blood increases so much that the respiratory centre forces you to gasp and take a breath.

Peripheral Chemoreceptor

A chemoreceptor, is a cell or group of cells that transducer a chemical signal into an action potential

Chemo receptors in the carotid arteries and aorta, detect the levels of carbon dioxide in the blood. To do this, they monitor the concentration of hydrogen ions in the blood, which increases the pH of the blood, as a direct consequence of the raised carbon dioxide concentration.
The response is that the inspiratory control from the apneustic centre, sends nervous impulses to the external intercostals muscles and the diaphragm, via the phrenic nerve to increase breathing rate and the volume of the lungs during inhalation.

4-11 <u>Respiratory volume</u>

- ***Total lung capacity (TC)*, about six liters, is all the air the lungs can hold.**
- ***Vital capacity (VC)* The maximum volume of air that can be expelled at the normal rate of exhalation after a maximum inspiration**

- *Tidal volume (TV)* **is the amount of air breathed in or out during normal respiration. It is normally from 450 to 500 mL.**
- *Residual volume (RV)* **is the amount of air left in the lungs after a maximal exhalation. This averages about 1.5 L.**
- *Expiratory reserve volume (ERV)* **is the amount of additional air that can be breathed out after normal expiration. This is about 1.5 L.**
- *Inspiratory reserve volume* **similarly, is the additional air that can be inhaled after a normal tidal breath in. About 2.5 more liters can be inhaled.**
- *Functional residual capacity,* **(ERV + RV), is the amount of air left in the lungs after a tidal breath out.**
- *Inspiratory capacity (IC)* **is the volume that can be inhaled after a tidal breath out.**
- **Anatomical dead space is the volume of the airways.**

Unit twelve

Renal system

1-12 structure of renal system

The renal system consists of all the organs involved in the formation and release of urine. It includes the kidneys, ureters, bladder and urethra.

1- The kidneys

are bean-shaped organs which help the body produce urine to get rid of unwanted waste substances. When urine is formed, tubes called ureters transport it to the urinary bladder, where it is stored and excreted via the urethra.

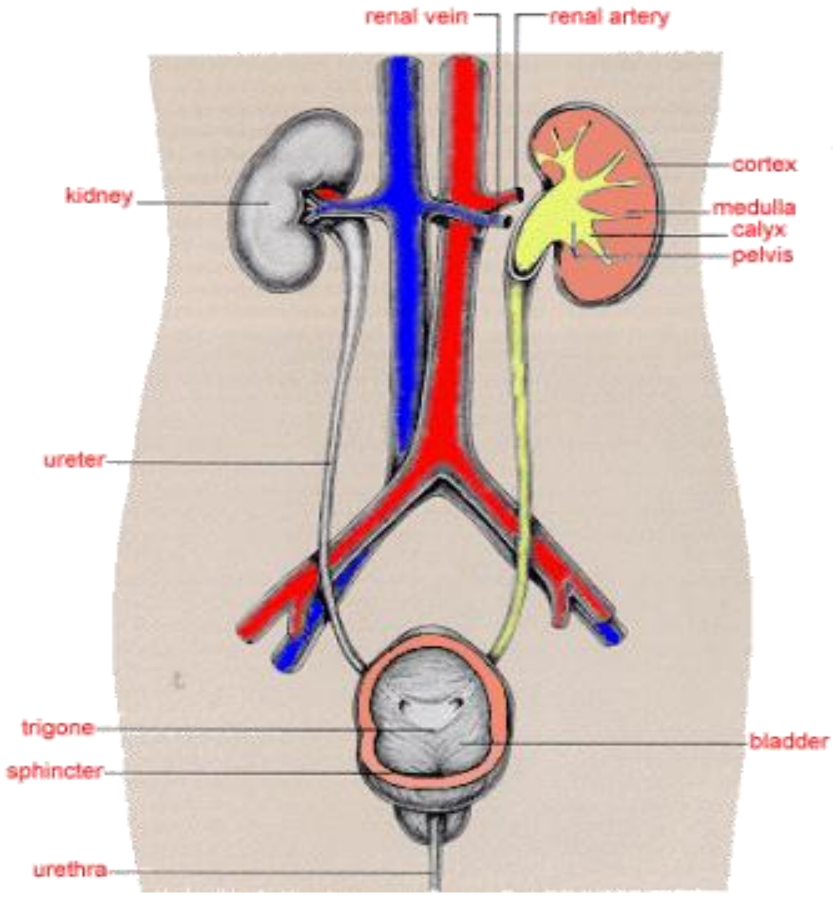
2- Bladder

The bladder is a pyramid-shaped organ which sits in the pelvis (the bony structure which helps form the hips). The main function of the bladder is to store urine and, under the appropriate signals, release it into a tube which carries the urine out of the body. Normally, the bladder can hold up to 500 mL of urine. The bladder has three openings: two for the ureters and one for the urethra (tube carrying urine out of the body). The bladder consists of smooth muscles. The main muscle of the bladder is called the detrusor muscle. Muscle fibres around the opening of the urethra forms a ring-like muscle that controls the passage of urine. When we want to urinate, stretch receptors in the bladder are activated, which send signals to our brain and tell us that the bladder is full. The ring-like muscle relaxes and the detrusor muscle contracts, allowing urine to flow. The blood supply of the bladder is from many blood vessels. Some of these blood vessels are named: the vesical arteries, the obturator, uterine, gluteal and vaginal arteries. In females, a venous network drains blood from the bladder arteries into the internal iliac vein. Nervous control of the bladder involves centres located in the brain and spinal cord

3- Urethra

The male urethra is 18–20 cm long, running from the bladder to the tip of the penis. The male urethra is supplied by the inferior vesical and middle rectal arteries. The veins follow these blood vessels. The nerve supply is via the pudendal nerve.

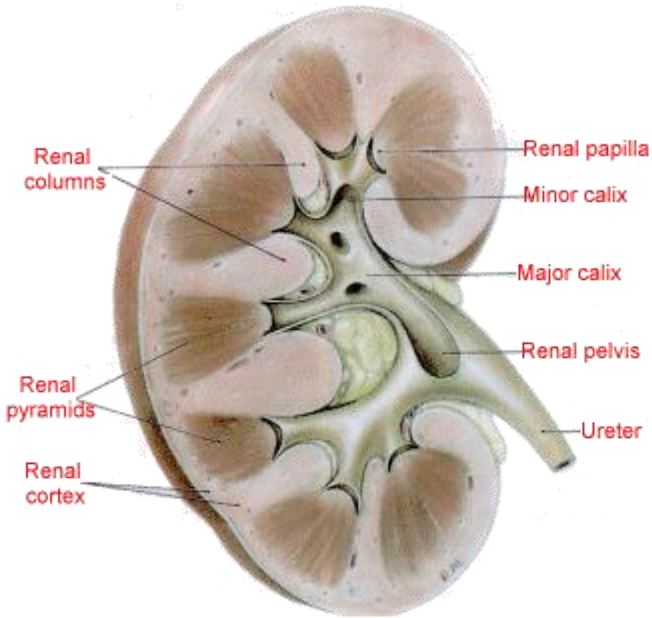
The female urethra is 4–6 cm long and 6 mm wide. It is a tube running from the bladder neck and opening into an external hole located at the top of the vaginal opening. As the female urethra is shorter than the male urethra, it is more likely to get infections from bacteria in the vagina. The female urethra is supplied by the internal pudendal and vaginal arteries.



2-12 <u>structure of kidney</u>

On sectioning, the kidney has a pale outer region- the cortex- and a darker inner region- the medulla.The medulla is divided into 8-18 conical regions, called the renal pyramids; the base of each pyramid starts at the corticomedullary border, and the apex ends in the renal papilla which merges to form the renal pelvis and then on to form the ureter. In humans, the renal pelvis is divided into two or three spaces -the major calyces- which in turn divide into further minor calyces. The walls of the calyces, pelvis and ureters are lined with smooth muscle that can contract to force urine towards the bladder by peristalisis.

The cortex and the medulla are made up of nephrons; these are the functional units of the kidney, and each kidney contains about 1.3 million of them.



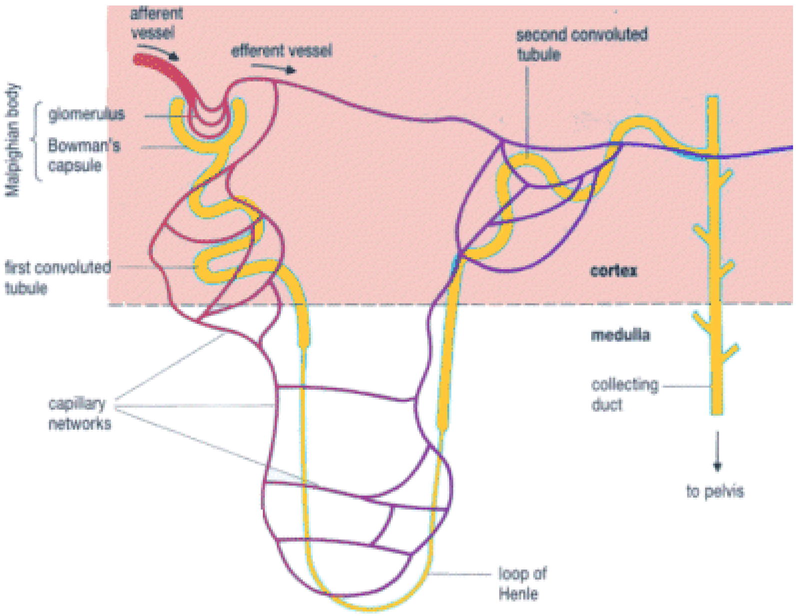
3-12 <u>structure of nephron</u>

The nephron is the unit of the kidney responsible for ultrafiltration of the blood and reabsorption or excretion of products in the subsequent filtrate. Each nephron is made up of:

- **A filtering unit- the glomerulus. 125ml/min of filtrate is formed by the kidneys as blood is filtered through this sieve-like structure. This filtration is uncontrolled.**
- **The proximal convoluted tubule. Controlled absorption of glucose, sodium, and other solutes goes on in this region.**
- **The loop of Henle. This region is responsible for concentration and dilution of urine by utilising a *counter-current multiplying* mechanism- basically, it is water-impermeable but can pump sodium out, which in turn**

affects the osmolarity of the surrounding tissues and will affect the subsequent movement of water in or out of the water-permeable collecting duct.

- **The distal convoluted tubule. This region is responsible, along with the collecting duct that it joins, for absorbing water back into the body- simple maths will tell you that the kidney doesn't produce 125ml of urine every minute. 99% of the water is normally reabsorbed, leaving highly concentrated urine to flow into the collecting duct and then into the renal pelvis.**



Test No.1

Describe the structure of nepheron

Test no.2

Enumerate the functions of kidney (this test for unit 13)

Unit thirteen

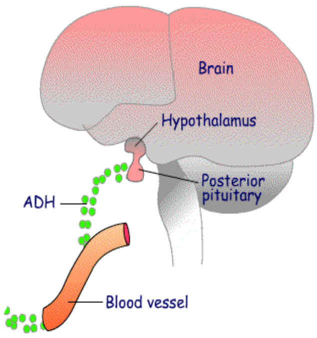
1-13 functions of the kidney

1. Control of the body's water balance. The amount of water in the body must be balanced against the amount of water which we

drink and the amount we lose in urine and sweat etc.
2. Regulation of blood pressure via the renin-angiotensin-aldosterone system
3. Regulation of blood electrolyte balance - Na^+, Ca^{2+}, K^+ etc.
4. Excretion of metabolic wastes such as urea, creatinine and foreign substances such as drugs and the chemicals we ingest with our food
5. Help in the regulation of the body's acid base balance
6. Regulation of red blood cell production via the hormone erythropoietin
7. Help in the production of vitamin D
As this list indicates, the renal system is very important to the normal functioning of the body.

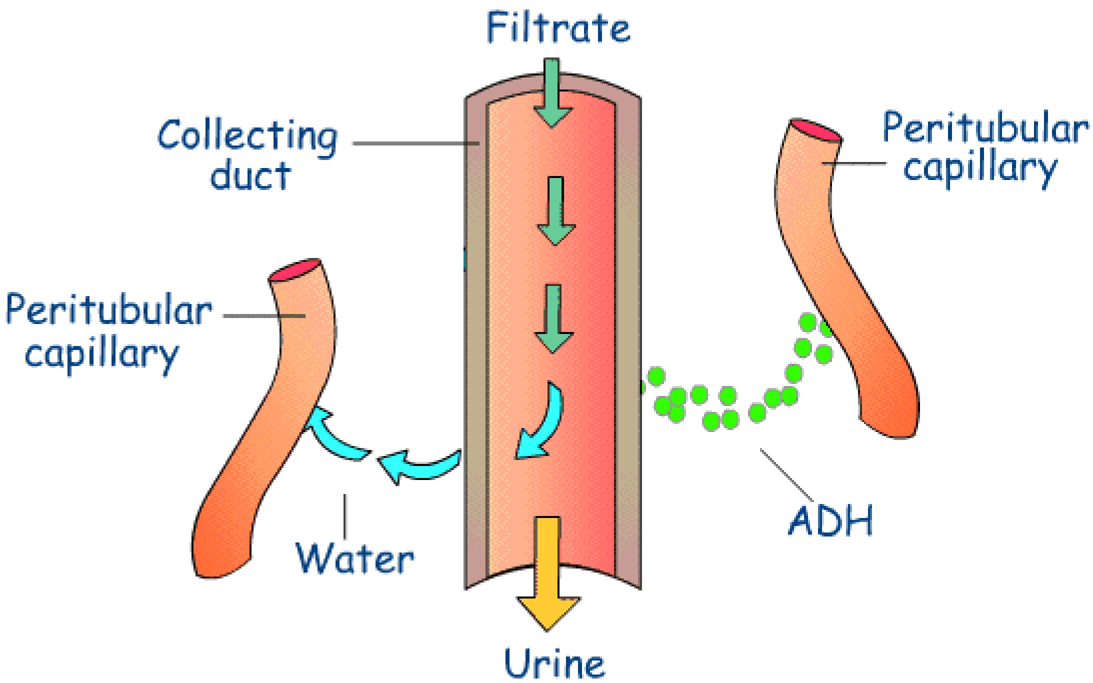
2-13 water regulations by the kidneys

The water content of the body can vary depending on various factors. Hot weather and physical activity such as exercise make us sweat and so lose body fluids. Drinking tends to be at irregular intervals when socially convenient. This means that sometimes the body has too little water and needs to conserve it and sometimes too much water and needs to get rid of it. Most of the control of water conservation takes place in the distal and collecting tubules of the nephrons under control of anti-diuretic hormone, (ADH), sometimes called vasopressin. This hormone is released by the posterior pituitary under control of the hypothalamus in the mid-brain area. The hypothalamus monitors the water content of the blood. If the blood contains too little water (indicating dehydration) then more ADH is released. If the blood contains too much water (indicating over-hydration) then less ADH is released into the blood stream



Release of ADH from the posterior pituitary into the bloodstream

ADH released from the pituitary travels in the blood stream to the peritubular capillaries of the nephron. ADH binds to receptors on the distal and collecting tubules of the nephrons which causes water channels to open in the tubule walls. This allows water to diffuse through the tubule walls into the interstitial fluid where it is collected by the peritubular capillaries. The more ADH present, the more water channels are open and the more water is reabsorbed - Figure



Reabsorption of water from the filtrate under the influence of ADH

Over 99% of the filtrate produced each day can be reabsorbed. The amount of water reabsorbed from the filtrate back into the blood depends on the water situation in the body. When the body is dehydrated, most of the filtrate is reabsorbed but note that even in cases of extreme of water shortage, the kidneys will continue to produce around 500 ml of urine each day in order to perform their excretory function.

Unit fourteen

1-14 The formation of urine

Filtration ,reaborption ,and secretion.

1- Filtration

Urine formation begins with the process of filtration, which goes on continually in the renal corpuscles.As blood courses through the glomeruli, much of its fluid, containing both useful chemicals and dissolved waste materials, soaks out of the blood through the membranes (by osmosis and diffusion) where it is filtered and then flows into the Bowman's capsule. This process is called glomerular filtration. The water, waste products, salt, glucose, and other chemicals that have been filtered out of the blood are known collectively as glomerular filtrate. The glomerular filtrate consists primarily of water, excess salts (primarily Na^+ and K^+), glucose, and a waste product of the body called urea. Urea is formed in the body to eliminate the very toxic ammonia products that are formed in the liver from amino acids. Since humans cannot excrete ammonia, it is converted to the less dangerous urea and then filtered out of the blood. Urea is the most abundant of the waste products that must be excreted by the kidneys. The total rate of glomerular filtration (glomerular filtration rate or GFR) for the whole body (i.e., for all of the nephrons in both kidneys) is

normally about 125 ml per minute. That is, about 125 ml of water and dissolved substances are filtered out of the blood per minute.

2- Reabsorption

Reabsorption, by definition, is the movement of substances out of the renal tubules back into the blood capillaries located around the tubules (called the peritubular copillaries). Substances reabsorbed are water, glucose and other nutrients, and sodium (Na^+) and other ions. Reabsorption begins in the proximal convoluted tubules and continues in the loop of Henle, distal convoluted tubules, and collecting tubules (Figure 3). Let's discuss for a moment the three main substances that are reabsorbed back into the bloodstream.

Large amounts of water - more than 178 liters per day - are reabsorbed back into the bloodstream from the proximal tubules because the physical forces acting on the water in these tubules actually push most of the water back into the blood capillaries. In other words, about 99% of the 180 liters of water that leave the blood each day by glomerular filtration returns to the blood from the proximal tubule through the process of passive reabsorption.

The nutrient glucose (blood sugar) is entirely reabsorbed back into the blood from the proximal tubules. In fact, it is actively transported out of the tubules and into the peritubular capillary blood. None of this valuable nutrient is wasted by being lost in the urine. However, even when the kidneys are operating at peak efficiency, the nephrons can reabsorb only so much sugar and water. Their limitations are dramatically illustrated in cases of diabetes mellitus, a disease which causes the amount of sugar in the blood to rise far above normal. As already mentioned, in ordinary cases all the glucose that seeps out through the glomeruli into the tubules is reabsorbed into the blood. But if too much is present, the tubules reach the limit of their ability to pass the sugar back into the bloodstream, and the tubules retain some of it. It is then carried along in the urine, often providing a doctor with

her first clue that a patient has diabetes mellitus. The value of urine as a diagnostic aid has been known to the world of medicine since as far back as the time of Hippocrates. Since then, examination of the urine has become a regular procedure for physicians as well as scientists.

Sodium ions (Na^+) and other ions are only partially reabsorbed from the renal tubules back into the blood. For the most part, however, sodium ions are actively transported back into blood from the tubular fluid. The amount of sodium reabsorbed varies from time to time; it depends largely on how much salt we take in from the foods that we eat. (As stated earlier, sodium is a major component of table salt, known chemically as sodium chloride.) As a person increases the amount of salt taken into the body, that person's kidneys decrease the amount of sodium reabsorption back into the blood. That is, more sodium is retained in the tubules. Therefore, the amount of salt excreted in the urine increases. The process works the other way as well. The less the salt intake, the greater the amount of sodium reabsorbed back into the blood, and the amount of salt excreted in the urine decreases.

3- <u>secreation</u>

Now, let's describe the third important process in the formation of urine. Secretion is the process by which substances move into the distal and collecting tubules from blood in the capillaries around these tubules. In this respect, secretion is reabsorption in reverse. Whereas reabsorption moves substances out of the tubules and into the blood, secretion moves substances out of the blood and into the tubules where they mix with the water and other wastes and are converted into urine. These substances are secreted through either an active transport mechanism or as a result of diffusion across the membrane. Substances secreted are hydrogen ions (H+), potassium ions (K+), ammonia (NH3), and certain drugs. Kidney tubule secretion plays a crucial role in maintaining

the body's acid-base balance, another example of an important body function that the kidney participates in.

Summary

In summary, three processes occurring in successive portions of the nephron accomplish the function of urine formation:

1. Filtration of water and dissolved substances out of the blood in the glomeruli and into Bowman's capsule;
2. Reabsorption of water and dissolved substances out of the kidney tubules back into the blood (note that this process prevents substances needed by the body from being lost in the urine);
3. Secretion of hydrogen ions (H^+), potassium ions (K^+), ammonia (NH_3), and certain drugs out of the blood and into the kidney tubules, where they are eventually eliminated in the urine.

2-14 <u>the urine</u>

is the fluid excreted by the kidneys. It consists of water, carrying in solution the body's waste products such as urea, uric acid, creatinine, organic acids, and also other solutes such as Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, the body fluid concentrations of which are regulated by the kidneys.
After being produced by the kidneys, urine passes along the *ureters* to be stored in the bladder, until it is allowed to flow out of the body through the urethra, in the process of *micturition* (urination). The smooth muscle of the bladder forms an internal sphincter at its junction with the urethra, and further along the urethra is the voluntary-control external sphincter. The bladder begins to contract (micturition reflex), and produces the desire to urinate, when its volume exceeds about 200 ml. However, if we do

not relax the external sphincter, the contractions subside, but return with increasing force and frequency as the bladder continues to fill. When the bladder volume is about 500 ml the micturition reflex may force open the internal sphincter and lead to a reflex relaxation of the external sphincter, so that urination occurs involuntarily.

Voluntary urination involves relaxation of the external sphincter and tensing of the abdominal muscles to increase abdominal pressure and compress the bladder, to initiate bladder contraction and relaxation of the internal sphincter.

Most people excrete about 1.5 litres of urine per day, but the volume can range (in healthy adults) from 400 ml up to about 25 litres, depending on fluid intake. In renal failure, there may be no urine production, and in the rare condition of untreated *diabetes insipidus*, the urine volume is consistently 25 litres/day. Urine is termed 'dilute' if its solute concentration (osmolality) is lower than that of the blood plasma, and 'concentrated' if its solute concentration is greater than that of the plasma.

Humans who are maximally conserving water — when their kidneys are reabsorbing as much as possible — can produce urine with a solute concentration (osmolality) about five times that of blood plasma. Many other animals can conserve water much more effectively. For example, cats, dogs, and rats can produce urine of ten times the plasma osmolality, and gerbils twenty times!

When voided, urine is normally sterile and clear, although it has a yellow colour due to the presence of pigments. However, small amounts of particulate matter such as epithelial cells and lipids may be present; these are 'casts'. Protein is not normally filtered from the blood plasma by the kidneys, so protein in the urine — *proteinuria* — is generally indicative of damage to the glomeruli, at the blind inner ends of the kidney tubules, where filtration occurs. The urine may also appear to contain blood (*haematuria*). This may be due to haemolysis in the bloodstream (breakdown of

red cells) so that some haemoglobin is released from them and excreted, or it may be due to the presence of whole red cells, as a result of bleeding in the kidneys or urinary tract.

Test No. 1

What is urine ? where and how it formed

Test No. 2

What is micturition ? how is it controlled ?

Unit fifteen

1-15 Kidney Stones

In some people, chemicals crystallize in the urine and form the beginning, of a kidney stone. These stones are very tiny when they form, smaller than a grain of sand, but gradually can grow over time to a 1/10 of an inch or larger. Urolithiasis is the term that refers to the presence of stones in the urinary tract, while nephrolithiasis refers to kidney stones. The size of the stone doesn't matter as much as where it is located.

When the stone sits in the kidney, it rarely causes problems, but when it falls into the ureter, it acts like a dam. As the kidney continues to function and make urine, pressure builds up behind the stone and causes the kidney to swell. This pressure is what causes the pain of a kidney stone, but it also helps push the stone along the course of the ureter. When the stone enters the bladder, the obstruction in the ureter is relieved and the symptoms of a kidney stone are resolved.

2-15 kidney stones causes

1- Heredity: Some people are more susceptible to forming kidney stones, and heredity may play a role. The majority of kidney stones are made of calcium, and hypercalciuria (high

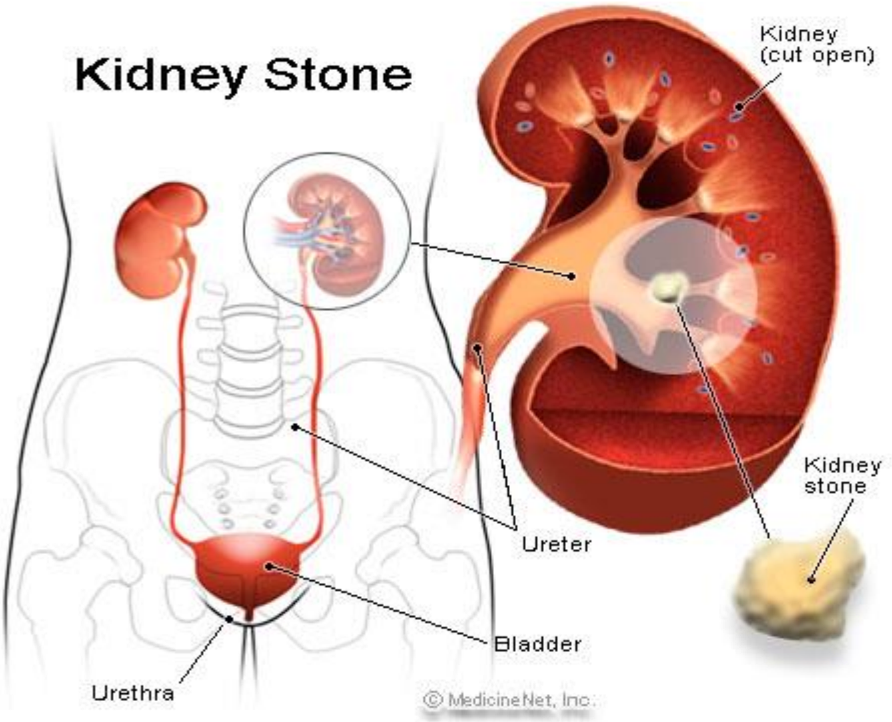
levels of calcium in the urine) is a risk factor. The predisposition to high levels of calcium in the urine may be passed on from generation to generation. Some rare hereditary diseases also predispose some people to form kidney stones. Examples include people with renal tubular acidosis and people with problems metabolizing a variety of chemicals including cystine (an amino acid), oxalate, (a type of salt), and uric acid (as in gout).

2- Geographical location: There may be a geographic predisposition to form kidney stones. There are regional "stone belts," with people living in the southern United States, having an increased risk of stone formation. The hot climate and poor fluid intake may cause people to be relatively dehydrated, with their urine becoming more concentrated and allowing chemicals to come in closer contact to form the nidus, or beginning, of a stone.

3- Diet: Diet may or may not be an issue. If a person is susceptible to forming stones, then foods high in calcium may increase the risk; however, if a person isn't susceptible to forming stones, diet will not change that risk.

4- Medications: People taking diuretics (or "water pills") and those who consume excess calcium-containing antacids can increase the amount of calcium in their urine and potentially increase their risk of forming stones. Taking excess amounts of vitamins A and D are also associated with higher levels of calcium in the urine. Patients with HIV who take the medication indinavir (Crixivan) can form indinavir stones. Other commonly prescribed medications associated with stone formation include dilantin and antibiotics like ceftriaxone (Rocephin) and ciprofloxacin (Cipro).

5- Underlying illnesses: Some chronic illnesses are associated with kidney stone formation, including cystic fibrosis, renal tubular acidosis, and inflammatory bowel disease.



Test no. 1

Enumerate the causes of Kidney stones

The source :

Gyton – Textbook – oxford publication London . **G.h. Green basic clinical physiology oxford publication 1976 .**
Barrett KE, Barman SM, Boitano S, Brooks HL. Gaming's Review of Medical 23rd ed. McGraw Hill, Physiology Boston, 2010 .
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