Chap 24

Materials Exchange in Body

Cells needs constant flow of Nutrient + release of wastes. And as the cells in the human are with organs + bodies in body, ≠ organ systems work together. These are:

1 - Cardiovascular
2 - Lymphatic
3 - respiratory
4 - digestive
5 - Excretory.

} Integrate their function

(1) Cardiovascular In human:

Organ that pumps blood around body
Consist of heart - blood + blood vessels.

Blood: fluid tissue that transport nutrients + Waste + heat.

Heart: Muscle that pump blood from one place in body to another in Vessels.

Arteries: Vessels that carry blood from heart to organs. in smaller arteries to tiny vessels called capillaries.

Capillaries: are thinnest blood vessels that exchange between blood vessels + tissue.

Veins: vessels that brings back the blood to heart.

Nature of blood:

Made of ≠ kinds cells + platelets in H_2O enviro-t called plasma table 24.1

Plasma contains Nutrients dissolved, waste, salt, prote...

gazes transported are O_2 + CO_2 -, it contains Antibodies Hormones, / substance that cause clotting.

- Heat that should be lost from body is radiated out at skin levels.

the — ay also lose heat through sweating

In Cold weather, blood supply to SK is less so that you do not lose heat + keep body warm

Cells

- RBC. Red blood Cells:

small - disc shape - No Nucleus - carry O_2/.

RBC contain a pigment that has Fe(iron) called hemoglobin which carry O_2.

By checking No's of RBC, + shape you can see if person has anemia or other disease related to RBC.

Anemia: condition that a person has low ability to carry O_2.

— ay be due to low Fe. iron

RBC are also involved in CO_2 transport + changing CO_2 to HCO_3^-. (CO_2 7% dissolved ~23% bind to Hb 70% as HCO_3^-)

Enzyme that change CO_2 into HCO_3^- is
- Carbonic Anhydrase. HCO_3^- goes in plasma

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

When blood reaches lungs HCO_3^- goes back inside RBC to be changed to CO_2. CO_2 diffuses out to be exhaled.

WBC: called Leukocytes

Larger than RBC., have Nucleus. ≠ shapes
Some are clear, Some have granules like basophils, ~~eosinophils~~ eosinophils, neutrophils.
Lymphocytes + monocytes are without granules.
These cells work to defend body against infections chemicals, cancer, microbes

Platelets: fragment of WBC. Needed for clotting

~ 200 billions are formed everyday.
they release clotting factors at site of wound.
~ 12 clotting factors. lead to fiber formation that trap RBC + seal wound

Plasma:

liquid part of Blood, H_2O, dissolved — ionic salt...

- They serves as buffers. to maintain a correct pH.
- Salt control blood's osmotic pressure.
- This keep fluid surrounding tissue
- Albumin is a main plasma protein important for osmotic balance.
- Albumin is considered a main transporter of ≠ Molecules in blood to liver to eliminate ; like bilirubin degradet of Hb, take to liver + excreted.
  If Not properly eliminated, person develop jaundice
- Plasma take nutrients from Intestine to all body.
  - aa + protein soluble.
  - lipid carried by proteins as they're not water soluble. called lipoprotein like VLDL, HDL, LDL...
  - Hormones produced by brain are carried by plasma reproductive orgs. digestive org. / glands

    tissues have receptors for ther hormones will be affected.

Heart

Heart provide energy to pump blood to all body.
There is ≠ in pressure bet Heart & target tissue.
heart contract & relax to propel blood throughout body.
It consists of 4 Chambers & 4 sets of values to ensure flow of blood in 1 direction.

Chambers → Atria (Atrium ①) (thin walled)
→ Ventricule

Blood ⟶ aves of Atria ⟶ Ventricles
Right & left-
Atria collect blood coming from major Vein & empty it in Ventricule.
Blood ⟶ aves to Ventricule due to lower Pressure in Ventricule when they relax.

Right & left
Ventricules ⟶ have ⟶ ascular walls to force blood to all body part.

- Valve bet Vent. & Atria is called Atrioventricular Valve.
- Also there are values bet Aorta & pulmonary artery. called Semilunar valve.
- Aorta: is the largest artery that carries blood of left Ventricle to body.
- Pulmonary artery carries blood of right ventricle to lungs.

Semi lunar valve prevent blood from flowing back into Ventricles.

If these valve do not work properly → heart disease. can be diagnosed by abnormal sounds called Heart Murmurs as blood passes thrgh the.

If ventricle becomes weak → can't pump blood properly to body → Chest pain / shortness of breath / fatigue due to ↗ lactic acid in heart muscle. because it's not getting enough O_2.

If heart muscle does not receive O_2 → that portion of muscle will die.

Right + left Side of Heart slightly differ in terms of jobs. as they pump blood to ≠ part of body.

Right Side receive blood from body + send it to pulmonary artery to lungs. to exchange O_2/CO_2 the return from lungs to left atrium.

This is called Pulmonary Circulation

the strong Left Side receive blood from lungs + send it through Aorta to all other body parts. + returns it to right atrium through Veins

This is called systemic circulation

Blood Vessels: Arteries, Veins, Capillaries

Arteries + Veins are tubes that transport blood from Heart to body + vice versa.

Arteries from Heart, Blood is under pressure from contraction of Ventricals. (That ↑ pressure in artery) ≈ 120 mm of Hg. This is known as Systolic Blood Pressure.

BP when Heart is relaxing is ≈ 80 mm of Hg. This is known as diastolic blood Pressure.

Walls of arteries are relatively thick + Muscular + Elastic.

Healthy arteries have ability to expand as blood is pumped through + go back to normal.

If artery became hard → BP ↑ → artery may rupture.

Blood goes from large aorta → smaller + smaller blood vessels to tiny capillaries

Small arteries are called arterioles.

also contract + relax to regulate flow of blood to parts of body.

Major parts of body that receive ≠ Volume of blood are digestive system, muscles, skin.

When a person blushes → large amount of blood flow to capillaries of skin. also when people exercise, muscles need more blood.

After a meal, blood flow to digestive system.

Veins collect blood from capillaries + return it to heart. Pressure is low in veins.

Walls of veins is not muscular like arteries.

Veins are found on surface of skin see as blue lines. Veins have valve to prevent blood from flowing backwards away from heart.

When these valve become faulty, person has varicose veins. (blood accumulate in legs + swell)

When muscle contract, this help blood go back to heart by pressing on veins.

Blood capillaries: assist in exchange of material between blood + cells.

they're thin walled tubes; receive blood from arterioles

RBC should go through these in line. Every cell in body has capillary nearby.

cell wall of capillary is made of a single layer of cell. → Very thin barrier of material exchange between blood + cells.

Liquid can also flow.

Flow is slow to allow exchange of materials.

24.3 The Lymphatic System:

They're thin walled tubes. Branch throughout body + lymph organs.

Main role: 1) Move fat from Intestine to blood stream

2) transport excess fluid back to cardiovascular system.

3) defends against Harmful agents as bacteria + virus.

Lymph is the fluid that move through this system.

Lymph vessels collect the lymph + empty it in large veins near the heart.

Lymph move one way through vessels as valve move. They have valves to prevent backflow.

If lymph does Not move, it cause edema (swelling). Also if capillary leak, this cause also edema

There are 5 lymph organs:

1) lymph nods.
2) Tonsils
3) Spleen
4) Thymus
5) Red bone marrow.

1) Nods are like small capsules along lymph vessels. Contain large No's of WBC., macrophages, lymphocyte
lymph is usually filtered in node as it move to circulatory system.
~~Blood~~ cells when active in filtering. check for Infection

Tonsils are lymph organs around throat made of 2 parts

1) - Palatine tonsils → Mostly known as tonsils
2) - pharyngeal adenoids.

work in clearing up pathogens. They're one first to clean up pathogen as they're close to mouth + nose.
also as become swollen.
They are usually removed by surgery if continously infected. called tonsillectomy.

Spleen: large Nos of WBC. filters blood.

- located in upper left side of body just below the diaphragm. It clean blood of pathogens + damaged RBC.
It may be removed if damaged. / loss immunity

- Thymus gland. Located over the breast bone.
It's large + active in Children. may shrink + disappear in adult.
Main function is to make WBC. called T lymphocytes. T lymphocytes are distributed from Thymus to body + ~~stay~~ establish themselves in lymph nodes.

- Red Bone Marrow, make RBC + WBC + Platelets.
Stem cells in bone marrow continues to divide all life. to supply RBC + WBC.
It's found in most Children's bone.
In adult, it's found in pelvis, sternum, skull, vertebrae..

24.4 Gas Exchange: Respiratory System:

Move air in + out of body. • Consist of

- Lung
- Trachea
- Air transport pathway
- Diaphragm.

- Lungs are organs where gas exchange take place. Both air + blood.

~~the~~ tubes that conduct air. Largest is Trachea.

Trachea is supported by rings of cartilage that prevent collapse.

It branches into 2 bronchi which leads to bronchioles. Bronchioles contain smooth muscles. + can constrict. • Bronchioles deliver air to small sacs called Alveoli. where exchange of gases both air + blood take place.

Nose + Mouth + throat also play a role. as they modify the Humidity + Temperature of air + clean air as it passes.

the lining of trachea contain cells with cilia, that beat in one direction to remove mucus + foreign materials from the lungs.

Foreign material will be either expelled or swallowed.

Breathing System Regulation:

Breathing is helped by a muscular organ called Diaphragm that separates chest cavity + lung from abdominal cavity.

+ Muscles located between ribs (Intercostal Muscles) are attached to ribs so that their contraction causes the chest wall to move outward + this ↑ size of chest cavity.

- During Inhalation, Diaphragm moves downward + Intercostal muscles of chest wall contract causing Volume of chest cavity to ↑. This causes ↓ in chest pressure compared to air outside. Thus, air will flow from out to in through trachea, bronchi, bronchioles, to alveoli.

During normal breathing, exhalation is accomplished by the chest wall + diaphragm returning to their normal, relaxed positions.
No muscular contraction (Fig 24.7).

During exercise, breathing rate ↑ + volume of air exchanged per breath ↑.

↑ in volume of air / breath can be accomplished in 2 ways: 1. Muscle of inhalation contract forcefully to ↑ volume of chest cavity

2- lungs can be emptied more completely by contracting muscles of abdomen by forcing abdominal contents upward against diaphragm + compressing the lungs with help of internal intercostal muscles.

- Main mechanism that causes changes in rate + depth of breathing is the $[CO_2]$ present in blood if CO_2 is not eliminated, it ↓ pH of blood + may lead to death
- CBs in aortic arch + carotid arteries respond to changes in blood pH., They send a signals to diaphragm + intercostal muscle to contract. leading to deeper breathing. Hence we lose more CO_2

when you finish exercising, blood pH ↑ → breathing rate to normal.

Lung Function

Lung allow contact bet^n blood + air. to allow exchange of gases. Blood flow through capillaries that is in contact with air at the level of alveoli.

Lungs has a large number of tiny alveoli ~ 0.25 → 5 mm total area reach 70 m^2. for efficient gas exchange

Fig 24.9.

2nd factor that ↑ efficiency of exchange is <u>movement</u> of blood + air. always CO_2 is lost + O_2 enter from High [ ] to low [ ].

this movement is <u>NOT Unidirectional</u> but <u>continuous</u>.

- Any factor that affect flow of blood or air will reduce efficacy of a person.

Poor Heart, asthmatic, ↓ in alveoli No. } all ↓ efficiency of gas exchange.

Like emphysema: Alveoli are lost gradually. may be due to ↑ in connective tissue that is lead to lost of elasticity + ↓ gas exchange.

Digestive System

- Responsible for . Processing + distribution of Nutrients.
- Made of Muscular tube + glands that secrete digestive juices into tube.
- Involve 4 activities: 1 Mechanical processing
  2 Chemical "
  3 Nutrient uptake
  4 Chemical alteration.

1+2 Processing

Digestive system break down large chunks of food into smaller ones. ~~tubes~~ can be distributed by blood to all body's. cells. : Mechanical processing

- chewing food allow easier chemical digestion
- H_2O addition disperse nutrient + ease digestion

This is done in Mouth + Stomach.

teeth grind + cut.

H_2O is added through saliva that is produced from 3 pairs of glands known as salivary glands.

It contains amylase that start starch degradation

Saliva acts as lubricant to ease swallowing.

taste buds on tongue identify type of food.
tongue help in pushing processed food to throat to swallow. Fig 24.6.

Through esophagus.
the food ball is known as bolus, It stimulate wall of throat (called pharynx) to push food to stomach.
- So Food does not enter lung through the pharynx the larynx is pulled upward causing a flap of tissue called epiglottis to cover trachae opening. + prevent food from going to trachae.

- In stomach, gastric juice are secreted which contains enzyms + HCl. ← low pH < 2
pepsin that acts proteins.

Hence Its low pH inhibit bacterial growth.
The food mix is churned by stomach contraction make it liquid (chyme)
The liquid leaves stomach to small intestin through a valve known as pyloric Sphincter.

First part of Intestine is called Duodenum. It secrets ≠ hormons that regulate food release from stomach + release of secretions from liver + pancreas.

Pancreas produces some digestive enzymes; HCO_3^- to adjust pH of liquified food in stomach. to ~ 8.

Liver secrete bile. Bile is stored in gall bladder before release in duodenum.

Bile help in digestion + ~~solubilization~~ emulsification of lipid to allow digestion.

In small intestine, ~~one~~ juices are secreted till ~~ixture~~ reach large Intestin (called colon). Large intest is ~~mo~~ mainly involved in reabsorbing water. It also harbors many bacteria Some of these bacteria are beneficial by producing vitamins. Some may cause diseases.

Nutrient Uptake:

After digestion, simple sugar, amino acids fatty acids are ~~—ove~~ to circulatory system through the large surface area of small intestine. Small Intest consists of large No's of projections called villi (Villus).

Surrounding the villi are capillaries to absorb nutrients + lymphatic vessels called Lacteal.

Molecule can diffuse by themselves as H_2O, some ions. & small intest blood.

Others require transporter.

Fatty acids are changed into Triglyceride in the intestinal lining + enter lacteals. The empty in circulatory.

Chemical Alteration: Role of liver

Blood leaving ~~Intestine~~, it flows directly to liver through the hepatic portal vein.

Portal veins are blood vessels that take blood & capillaries to other capillaries without passing through heart.

this circulation take nutrients directly to liver to modify the molecules.
where foreign organic are filtered from blood
it also detoxify large no of dangerous molecules.
like ethanol,
liver also modify nutrients, change glucose → glycogen that is stored in liver for later use.
- liver also change some aa. to other kind of aa.
it also eliminate NH_3 in the form of urea.

24.6 Waste Disposal: Excretory system.

Excretory system is organ that process & eliminate of metabolic waste products. Consists of kidney, ureters, Urinary bladder, & urethra.

Urea is a common waste, ions H^+, H_2O, salts.

Kidney Structure:

It's made of 2.4 million tiny units called Nephron
Nephron is made of a bowman's capsule, which is surrounded by a capillary knot known as glomerulus.

The capsule is linked to tubules that are proximal, Loop of Henle, distal convoluted tubule. distal is connected to a collecting duct that transport fluid to ureters then to bladder where It's stored + eliminated through urethra (urinary).

Kidney function:

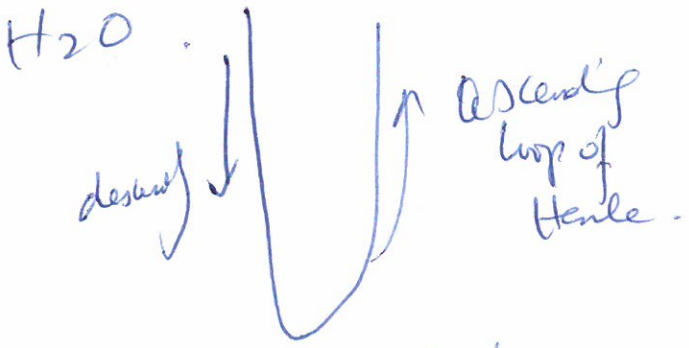
Large surface area of nephron allow the activity
- filtration - reabsorption - secretion.

Blood enter glomerules under high pressure of Heart
Capillaries of glomerules are porous + H2O +
small molecule can cross into Bowman capsule.
glucose, aa, ions, H2O can pass.
Large molecules like prote, cells, can't pass.
Volume filtered through all nephrons is ≈ 7.5 L/hour.

- Some molecule are by passive transport
others are by active transport.
- Some molecules are reabsorbed at the
level of proximal tubules + return to blood.
water follows the molecule that is absorbed (high [] to low []).

by the fluid reach end of proximal tubule, 65% of fluid has been reabsorbed.

Next is loop of Henle, Main function is to reabsorb H_2O.



Ascending ~~transport~~ reabsorb Na^+, close to it is collecting duct. Na^+ is as close, ⟶ more H_2O leave duct + enter capillaries.

H_2O ⟶ more at trough collecting duct is regulated by Hormone. (called ADH anti-diuretic hormone)

Hence, we can regulate H_2O loss by regulating H_2O that is reabsorbed at level of collecting duct.

During dehydration, most H_2O is reabsorbed. + little urine is produced.

If body has excess H_2O, Hypothalamus send a signal to pituitary to produce small amount ADH + this cause H_2O loss. is released.

During dehydration ⟶ more ADH is released + H_2O leaves collecting duct + goes back to blood.

- The distal convoluted tubule is involved in fine tuning the ions lost in urine.

like H^+, Na^+, Cl^-, K^+, NH_4^+ are regulated in distal tubule.

Urea is not reabsorbed, but lost in urine, also other drugs are lost in urine.

See fig 24.14