Biology 12 notes

Science, Biology

The Excretory System •Main functions of the excretory system are: oto concentrate wastes and expel them from the body oto regulate fluids and water within the body •Most metabolic wastes and toxins are dissolved in the body’s internalenvironment, so the maintenance of the body fluids is essential for keeping the body free of waste products enabling it to function properly. Excretion in Invertebrates and Non-mammaliam Vertebrates Single celled organisms and simple multicellular organisms produce the same metabolic wastes and toxic compounds as more complex organism •However wastes are excreted directly from their cells since they have constant contact with the external environment. •The greater challenge for simple organisms is maintaining a fluid balance with their external environment •An example is paramecium: If they are not able to maintain a fluid balance they would continuously absorb water from the environment and eventually burst oTo expel excess water, these protozoans have contractile vacuoles, which pump out water to maintain osmotic balance •More complex organisms face different challenges •Some invertebrates such as earthworms have excretory organs called matanephridia that expel wastes from the body. oA fluid that serves as both interstitial fluid and bood known as hemolymph flows into a pair of metanphridia. olons and wastes are reabsorbed from the hemolymph and secreted with water into a saclike organ called the bladder.

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From there, the excess water and waste products are secreted to the external environment through a poke in the side of the worm’s body. •Insects like grasshoppers excrete wastes uses a set of organs called

malpighian tubules. oThe closed end of the organs are surrounded with hemolymph while open ends empty into intestines. oSubstances, such as uric acid, and potassium and sodium ions are secreted into the tubules. oWhen concentration of the substances increases, water movies osmotically from the hemolymph into the tubule to orm a dilute waste solution and then it travels to the intestine of the insect where the cells reabsorb most of the K+ and Na+ back into hemolymph oWater moves back and forth using osmosis. oUric acid is left behind and forms crystals and is then expelled •Terrestrial reptiles and most birds conserve water by excreting nitrogenous wastes in the form of an almost water free paste of uric acid crystals. oIt's excreted into the cloaca (end of the digestive system) and removed from the body along with the digestive wastes oThe white substance in bird droppings is uric acid while the darker substance is feces. Those that live in or around salt water take in large quantities of salt and rarely drink fresh water therefore they excrete excess salt through specialized salt glands in the head. oSalt glands remove salts from the blood using active transport. oSalt is secreted to the environment as a water solution oThe concentration of this is two to three times more than that in the body fluids. oSecretion exits through the nostril of birds and lizards and as salty tears from sea turtles and crocodilians. The Human Excretory System All vertebrates used specialized tubules called nephrons to regulate water balance in the body and conduct excretion. •They are located in the kidneys which are the major organs of excretory. •The kidneys, ureters, bladder, and the urethra together make up the human excretory system. Kidneys •Play a critical role in oRemoving wastes oBalancing blood pH oMaintaining the body's water balance

•Mammals have two kidneys on each side of the vertebrate column •Human kidneys: o150g oreceives 25% of cardiac output (1. 25 L/min.) •Blood is supplied through renal artery. “ Renal” refers to the kidneys •Kidney filters the wastes from the blood and clean blood exits the kidney through the renal veins. •Outer layer of the kidney is called the renal cortex •Inner layer is called the renal medulla •A hollow cavity called the renal pelvis, connects the kidney to the ureter through which the urine passes to the urinary bladder. •Once the bladder is full, (300 to 400 mL of urine) the urine exits through the urethra Nephrons •Each kidney contains about 1 000 000 nephrons •They are the functional unit of a kidney Nephrons are differentiated into regions to perform a serioes of steps •One end is the bowman’s capsule which is a small folded structure that encircles a group of blood capillaries, the glomerulus in the cortex •The glomerulus performs the first step of filtration of blood to form urine •Blood is supplied to the glomerulus by the afferent arteriole and then after being filtered it exits via efferent arteriole and then called into net capillaries called the peritubular capillaries. •They carry the urine and allow for reabsorption of essential ions and minerals back into bloodstream. First Steps of Filtration Components of unfiltered blood pass from glomerulus into the bowman’s capsule and enter a proximal convoluted tubule which lies in the cortex •The tubule descends into the medulla and forms a u shaped structure called loop of Henle before rising again to form a distal convoluted tubule •The distal tubule drains the urine into collecting ducts that lead to renal pelvis and then it is emptied through the ureter to the bladder The Formation of Urine •Different sections of the nephron have specialized functions in the formation of urine and

conservation of water •Urine is hypoosmotic in ammals meaning that water tends to move from urine into the body fluids this is an adaptation that conserves water •Three features of nephrons: 1. Conserve nutrients and water 2. Balance salts 3. Concentrate wastes for excretion •Urine formation is the result of three interrelated processes: oFiltration: occurs when the body fluids move from the blood into the bowman's capsule oReabsorption: transfers essential solutes and water from the nephrons back into the blood oSecretion: transfers essential solutes and water from the nephron back into the blood Filtration Urine formation begins in the bowman's capsule •The cells of the bowmans capsule and the capillaries that surround it have a selectively permeable membrane that are wide enough to admit water, ions, small nutrient molecules (glucose and amino acids), and nitrogenous waste molecules. •The high pressure of blood in the glomerule drives the fuid that contrains these molecules and ions into the capsule. Blood cells, platelets and plasma proteins are too large therefore they are retained in capillaries •Fluid enters the bowman's capsule contains only small molecules •This is known as filtration

Reabsorption •The filtered fluid contains urea, water, ions, and other molecules that are in the same concentrations as they are in the blood plasma. •The fluid enters the proximal convoluted tubule where reabsorption occurs •Water, ions, and nutrients are transferred back via passive and active transport •Speclizied ion pumps transport postassium sodium and chlorine from the filtrate into the fluid surrounding the tubule. •Active transport proteins in the walls of tubule reabsorb amino acids glucose and other nutrients •Urea and other unwanted compounds are not absorbed

Microvilli in the inner walls increases surface area that is available for reabsorption of solutes •All of the Reabsorption processes make the filtrate hypoosmotic to the interstitial fluid, this causes water to flow out of the tubule and into interstitial fluid by osmosis •The movement of water is facilitated by membrane proteins called aquaporins or water channels •They ensure that the maximum amount of water is removed from the tubule during reabsorption •The remaining fluid has a high concentration of urea and other wastes moves into the loop of henle. More water is absorbed •Then as it goes up the ascending the Na and Cl are out of the tubule •Towards the top of the ascending segment ions are moved out by active transport •Thus as the fluid flows through the loop og henle water nutrients and ions are conserved and returned to body fluids and urea and other nitrogenous wastes have become concentrated in the filtrate •The distal convoluted tubule removes additional water and salts •Ore ions and solutes more out of the fluid than into it •Amount of urea and other nitrogenous wastes remain the same. Concentrated urea and wastes flow into the collecting ducts which concentrated the urine more •Collecting ducts decend from cortex through medulla •Permeable to water but not to salt ions •Concentration of solutes increases with depth as fluid decends into the medulla Secretion •Removal of waste products from blood and fluids •Wastes are secreted at several points •Some wastes are secreted rom interstitial fluid into proximal convoluted tubule •H+ ions are actively secreted and the products of detoxified poisons from liver are passively secreted •Ammonia secreted into the tubule Secretion of H+ ions into the filtrate helps to balance the acidity that is generated constantly •hormones

triggered by changes in salt concentrations vary the amounts of K+ and H+ secreted •if acidity rises the excess H+ ions are secreted into collecting ducts and excreted •when urine reaches the bottom of the collecting ducts it is roughly 4x as concentrate •urine flows into the renal pelvis through the ureters and into the bladder Kidney Disease must function properly to maintain water balance and homeostasis •they are affected by disease or injury in other parts of the body because in contact with blood and wastes from everywhere •break down of kidney can impact any organ •urinalysis: contents of urine are analyzed for traces of metabolites and molecules that result from disease •diabetesmellitus: is caused by insufficient secretion of insulin causes blood sugar level to rise •it can be detected in urinalysis •kidney stone re an affliction of E. S. caused by the buildup of mineral solutes such as oxalates phosphates and carbonates. These combine with calcium to produce crystals that accumulate and form stones the can cause pain because they are sharp stones •Broken up by high energy sound waves in process called extracorporeal shoch wave lithotripsy ESWL •Also can be removed by uteroscope or surgery •Loss of kidney function requires the use of dialysis •In dialysis blood is run through filtering machine and the loss of kidney function results to need of kidney transplant ? Definitions 1. Contractile Vacuole: A structure in a single-celled organism that maintains osmotic equilibrium by pumping excess fluid out of the cell. . Metanephridium: An excretory organ in some invertebrates that is used to reabsorb and eliminate wastes 3. Malpighian Tubule: the main organ of exretion in insects, which is used to carry wastes to the intestines 4. Nephron: the tiny functional unit of the kidney that filters wastes from the

blood 5. Bowman’s Capsule: a small folded structure in the human kidney that encircles the glomerulus 6. Glomerulus: a network of capillaries within the Bowman’s capsule that perform the first step in the filtration of blood 7.

Afferent arteriole: A vessel that supplies blood to the nephrons in the human kidneys

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8. Efferent arteriole: A vessel that carries blood from the nephrons in the human kidneys 9. Peritubular Capillaries: a net of capillaries in the nephrons that reabsorb essential ions and minerals from filtered blood 10. Proximal convoluted tubule: the duct portion of a nephron that connects the bowman’s capsule to the loop of Henle 11. Loop of Henle: the U-shaped part of the duct that connects the proximal convoluted tubule to the distal convoluted tubule 12.

Distal convoluted tubule: the duct portion of a nephron that connects the loop of Henle to the ducts that lead to the renal pelvis 13. Filtration: the process in which blood and fluid pass through a selectively permeable membrane 14. Reabsorption: the transfer of water, ions, and nutrients back to the interstitial fluid via passive and active transport 15. Aquaporin: a membrane protein that passively transports water molecules 16. Secretion: the removal of waste materials from the blood and intercellular fluid