9/9/16

I. Animal Digestion

Nutrients

Trace Nutrients

Vitamins

Minerals (Zinc, Iron)

-Once food is acquired food is mechanically processed

-After mechanical processing food is chemically processed in enzymes and acids

so that it can be used for energy.

-Extracellular digestion: chemical processing that takes places in the body

but outside cells

-Takes places in a thin piece of tissues that covers a structure or

lines a cavity (glands digestive epithelia)

-Digestive juices

-All animals use this

-Intracellular digestion: chunks of food are engulfed by cells through

endocytosis and packaged in digestive vacuoles

-Only simple animals use intracellular digestion

-After food is processed mechanically and chemically food is absorbed across

the digestive epithelia which typically has a greatly enlarged surface

(exchange surface).

-Exchange surfaces always have an interface with the circulatory system for

distribution.

-Finally undigested waste is eliminated.

II. Digestive Systems: Structural View

A. Digestive Cavity = gastrovascular cavity

1.Hydra

2. Flatworm

a.These animals are built like a sack with only a single opening

i. Both food and waste traverse the same opening

ii. Digestive skin that lines the gastrovascular cavity is .....

iii. Gland cells release enzymes to chemically process food

(extracellular)

iv. cannot chew

v. two types of cells in the gastrovascular: one for secretion of

digestive juices and one for abortion

B. Digestive Track = food moves in one direction

1. Tube within a tube

2. Food enters through the mouth, is deconstructed, and exits through the

anus

i. Mouth, esophagus, crop (storage so more food can be collected before

it is processed), gizzard (muscular organ that future mechanically

processed food), stomach, intestine (furthuer processed and absorbed)

III. Herbivores: Animals that feed on mostly plants

A. Problems using plants as food

1. Plants have indigestible cell wall made of cellulose (no animals have

enzymes to break down cellulose)

2.Leaves and stems are less calorie dense and protein dense than animals

3. Plants have defense (spices, aromatic, nutmeg), sutural defenses

(spines, crystals)

B. Chemical Processing

1. Microorganisms in a cow digest sugar and breakdown fat to produces

various absorbable products but also a lot of methane (greenhouse gas).

2. Rabbits use cecotropes

9/12/16

I. Metabolism: Food + 0\_2 -> Energy + Nutrients + wastes

A. 10^4 years ago - reducing atmosphere (little 0\_2)

1. Photosynthesis (C0\_2 + H\_20 -> sugars + 0\_2)

i. Energy stored as ATP

B. Metabolic Pathways (both used in humans)

1. Anaerobic pathway (no 0\_2) - glycolysis and fermentation

i. 1 glucose / 2ATP

ii. Used in humans as bust activity

2. Aerobic Pathway (0\_2) - Citric acid cycle and electron transport chain

ii. 1 glucose / 34 ATP

C. Structures

1. Acquisition of 0-2

A. Mechanism of 0\_2 Acquisition

1. Diffusion - movement of molecules from one place to another as a

result of their internal heat energy

2. Diffusion for 0\_2 always occurs across a body surface

3. No active transport

i. Factors that affect rate of diffusion

1. Concentration difference - solutes always move from an area of

high contention to an area of low concentration

2. Area across which diffusion occurs - bigger surface area ->

faster diffusion

3. Density of the medium (physical environment)

4. Oxygen availability

a. air 21% 0\_2

b. water 1% 0\_2 (warm water hold less 0\_2 than cold water) (sea

water hold less 0\_2 than fresh water) (animals also deplete 0\_2 in

their immediate surroundings)

2. Respiratory Surfaces

A. Unoccupied Surface

1. Diffusion across body surface is sufficient if no cell is no

cell is more than .5mm from the surface

i. No specialized respiratory system required if the animal is

very small < 1mm diameter or very flat

2. Ventilation - brings fresh medium (higher concentration of 0\_2)

to the respiratory surface

3. Body size and Evolution of Specialized Respiratory Surfaces

i. Always wet because and inside a body cavity 0\_2 must be in

solution in the body

ii. Large surface area / mulit-layered (alveoli in mammals)

iii. Thin wall (usually 1 cell thick) so that 0\_2 does not need

to travel for to get into the circulatory system

iv. In most animals tightly connected to the circulatory system

(well vascularized). Animals ventilate outside of the surface and

perfusions carries 0\_2 away from the surface. Perfusion is the

movement of 0\_2 away from the respiratory system, thereby

reducing the concentration of 0\_2 in the respiratory tissue.

This increase the rate of diffusion of 0\_2 in to the respiratory

system.

v. Countercurrent Exchanger - structures in which fluids flow in

opposite directions on wither side of a membrane to maintain a

large concentration gradient (opposite of concurrent)

3. Pay attention to insect tracheal system\*

4. Pay attention to respiratory system of birds\*

2. Destitution of 0\_2

3. Utilization (cellular metabolism)

9/14/15

(Lecture 3)

-Pressure in a chamber varies inversely with volume

-Positive or negative pressure is created in a respiratory chambers

-Fish use a two step process (one way flow)

1. Mouth open / operculum closed / pharynx expands

2. Mouth closed / operculum open / pharynx contracts

-Nostrils are values that can be opened and closed

-The glottis is a values between the pharynx and the lungs

-Frogs (and other reptiles) have a 4 step ventilation process

1. Lowers the floor of the mouth inhales through the nostrils

2. Closes nostrils, opens glottis, and elevates the floor of the mouth,

forcing air into the lungs

3.Rythmic ventilation assists in gas exchange

4. Air is forced out when muscles in the body wall above the lungs contract

and the lungs recoil elastically.

-Mammals have a two step system because the diaphragm controls in the info and

out flow of air

-Lungs are held within the thoracic cavity

-When the diaphragm contracts the pressure in the thoracic cavity decrease

and the lungs fill passively

-Intercostal muscles assists

-The rising diaphragm reduces the size of the thoracic cavity and increases

the pressure

-Read about birds

(Lecture 4)

-All large animals have respiratory system and circulatory systems to transport

oxygen across the ..

-Metabolic wastes, C02, nitrogen waste, cell and molecules of the immune system,

hormones are also transported by the circulatory system

-Vascular fluid blood: vertebrates and hemolymph in invertebrates

-Basic structural units create a driving force for vascular fluid

-The hear is a muscular organ that creates pressure

-Some animals have a tube heart

-Peristaltic contractions (waves of contraction)

-Hemolymph movement is almost continuous

-Some animals have a chamber heart

-Compartments that collect or distribute vascular fluid

-Pulsing contraction (not continuous) beat-rest-beat cycle

-Burst flow

-Arteries carry blood away from the heart

-Large diameter

-Inner layer is endothelium which is surrounded by smoother muscle and tough

connected tissue

-Arteries are still and strong because arterial blood is under high pressure

-Branch off into arterioles

-Veins have the same basic structure but the diameter is larger and there is

less stiff connective tissue

-Many veins have values that respond to blood pressure to prevent

backflow

-Capillary Network: inner layer of endothelium all exchanges takes place here

-Finely branched

-Sphincters turn capillary beds on and off

-Diffusion and active transport (spends energy)

-Filtration is bulk flow

-Interstitial fluid surrounds cells and tissue

-Material flows as follows (and in reverse): Capillaries -> interstitial

fluid -> cells

-Hydrostatic pressure is blood pressure - pushing pressure

-Pushes materials through leaky capillaries into the interstitial fluid

-Osmotic pressure opposed hydrostatic pressure

-Osmosis- water moves from area of high solute concentration to areas of low

concentration (sort of like diffusion)

-Osmotic pressure is a measure of the tendency to attract water molecules

-Issue with illustration: osmotic pressure is inside capillaries not the

interstitial fluid.

-Osmotic pressure is established but proteins

-Osmotic pressure in capillary bed does not change over the length of the

capillary bed

-At the delivery side (arterial) the "push out force wins"

-On the vein side is the "pulling force wins"

-Capillaries both delivery and collect garbage

-Open vs. Closed Circuits

-Open circuit: vascular fluid not always in capillaries

-Closed circuit: vascular fluid always in vesicles

-Blood is distinct from the interstitial fluid

-Circulatory Circuits

-Pulmonary/pulmocutaneous (O2 through skin)

-02 acquiring

-Systemic (delivery part)

9/16/16

-Circulatory System in Invertebrates

-Mollusks

-Most (snail, clam, muscle): open circulatory system

-Cephalopod (octopus, squid): gill heart creates high hydrostatic pressure

-Close circulatory system

-Insects

-Tracheal system in insects: collect O2 from the air

-Circulatory system does not deliver 02

-Circulation in vertebrates

-All closed

-Pulmonary Circuit

-Fishes

-Chambered (2) heart arranged in series

-From the heart the blood flows under high pressure to the gills

-Then the blood flows under low pressure to systemic circuit

-Circulation in Amphibians

-Parallel circuits all tetrapods

-Blood reaches tissue under high pressure

-Two atria at the top and one ventricle (pumping chamber)

-There is some mixing of oxy and deoxy blood because there is only one

ventricle

-Circulation in Mammals and birds

-Two atria and two ventricles

-No mixing of oxy and deoxy blood

-Most efficient delivery of 02 throughout the body

-The circulatory system's function in transport of blood/hemolymph

-Fluid compartments

-blood/hemolymph carries various molecules (hormones, 02)

-lymph/lymphatic: set of structures that recovers excess water

-Interstitial fluid: body fluid between structures

-Intracellular fluid

-Free exchanges of water and small molecules between each of these

compartments

-Composition of blood

-Classified as a connective tissue (embedded in a matrix)

-In the case of blood the matrix is called plasma (90% water and lots of

solutes)

-Solutes

-Plasma proteins (large molecules) which stay in vessels, contribute to

osmotic pressure, maintain blood viscosity, maintain blood pH, carry

fats, participate in immune response, assist in blood flow

-Inorganic Ions: electrolytes, organic nutrients (glucose, amino acids,

fatty acids, dissolved gasses/CO2/O2) nitrogen waste products, hormones

-Like interstitial fluid

-Cellular components

-Erythrocytes: red blood cells

-Made in bone marrow, destroyed in liver and spleen

-No nucleus and no internal structures

-Disk-shaped cells meant to carry 02

-Leukocytes

-Larger than red blood cells

-Diverse types

-Immune response

-Platelets

-Cell fragments

-Initiate clotting

-Respiratory Pigments

-Protein bound to an organic molecules and a metal atom

-In vertebrates its called hemoglobin Hb

-Metal atom in iron (red color)

-250\*10^6 molecule per RBC

-Contained in RBC to maintain blood viscosity and molality

-In invertebrates: hemoXXXXX

-Metal atom is copper (gives green color)

-Hb

-Uptake of O2 (loading)

-Release of O2 (unloading)

-Function of Respiratory

-Partial press of a gas : the fraction of the total pressure of a gas

mixture that can be attributed to one component of a mixture

P\_O2 = P\_air \* %O2

P\_O2 = P\_air \* 20%

-O2 dissociation curve

-How much O2 carried is the % saturation

-% saturation is a function of the partial pressure of a gas

-Graph

-% Saturation (y axis / dependent variable) vs Partial Pressure O2 (x

axis / independent variable)

-Hb is response to pH called the Bohr effect (Bohr shift: shifted

right)

-At low pH Hb holds less O2

-Acidity lowers the affinity for O2

-Gives up O2 to active tissues

-CO2 Elimination

-Acidosis

- C02 + H2O <-> H2CO3 (carbonic acid) <-> H+ + HCO3 (bicarbonate)

-Blood can buffer itself

-Buffering increase ability to absorb H+

-CO2 occurs at low concentration in the atmosphere and is easy to lose

9/19/20

-Defense against pathogens

-Innate defenses

-Generalized responses that occur without any prior experience with the

invading material

-Skin and mucus membrane (nose, throat, intestine)

-Leukocytes: consume or disable foreign material

-Inflammation: initiated when mast cells secrete histamine (increase local

blood supply and number of leukocytes)

-Antimicrobial proteins: create holes in cells and cause them to burst

-Specific defenses

-Adaptive immune response (acquired immune response)

-Based on prior experience with foreign material

-Distinguishes between self and non-self

-Non-self get eliminated

-An antigen is any substances (usually protein or poly saccharide) that the

system recognizes as non self

-An antibody is a protein molecule that identifies and binds to an antigen

-The antibody may be used as a tag and clump antigens together to be

consumed by leukocytes

-Antibodies recognize antigenic determinants (epitope)

-Cells of core, lymph, immune system

-Originated in the bone marrow

-Being as a pluripotent stem cell (no genes are turned on or turned off)

-Lymphoid stem cell develops into 1 of 2 types of immune cells

-Active cells in immune system T and B cells (key to immune system)

-B lymphocytes mature and originate in bone marrow

-B cells secrete antibodies

-Responsible for antibody mediated immune response

-T lymphocytes mature in the thymus

-receptor proteins on surface

-Bind foreign material and participate in two aspects of the immune

response

-CD4 T cells develop into helper T cells and help to activate B cells

-CD8 T cells develop into killer cells (cytotoxic T cells)

-Kills one body cells infected with a virus

-Cell mediated immune response

-Maturation of these cells: attain immune competence (mature and

participate in an aspect of the immune response)

-Beginning of the immune response is called lymphocyte activation

-Produces a cone of B cells that are functional called Clonal selection

-B cells in clone turn into plasma cell (fight infection now) and in

additional to that some of the clonal cells become memory B cells

-Takes two weeks to peak

-Stay in the body in case there is an infection by the same agent in the

future

-Response to a second infection is stronger and faster

-Essentials of antibody-mediated response

-B cell activation

-5 classes of antibodies called immunoglobulins

-IgG

-Agglutination clump of bacterial clumped together by antibodies which is

consumed by macrophages

-B Cells require chemical signal form T cell to stimulate clonal selection

-Major histocompatibility complex (MHC)

-Parts of this chapter can be ignored

-Cell Mediated Response

-CD8 T cells (not mature) can recognize combination of self and antigenic

determinate

-Becomes cytogenetic cell

-Secrete perferin to kill virus infected cells

9/21/16

-Homeostasis

-Get definition here

-Body Fluids

-Blood, hemolymph, lymph, interstitial fluid, intracellular fluid

-Diffusion of O\_2 across a respiratory surface and osmosis

-Solute and Water Balance

-Paths of water flux

-Water Flux is the movement of water into and out of animals, gains and losses of

water

-Gain

-drinking

-eating

-metabolic water

-absorb through skin

-Loss

-Urine

-Feces

-Evaporation

-Body surface

-Respiratory

-Lactation

-Physiologically Wet and Physiologically Dry

-Compare solute concentration in environment vs concentration in animal

-High environment concentration -> hyperosmotic to animal

-High environment concentration -> hypostatic to the environment

-Water moves from the animal to the environment

-Salts move from the environment to the animal

-Physiologically dry (physiologically wet is the opposite)

-Salt water fish actively pump out ions it gains when drinking the water

-Releases a very small amount of highly concentrated urine

-Fresh water fish actively pump salt in across the gills

-Produce a large volume of dilute urine

-Land animals are always in danger of dehydration

-terrestrial (literally dry)

-Osmoconformers and Osmoregulaters

-Osmoconformers- salt concentration varies a lot during the day

-Marine invertebrates

-Osmoregulators- regulate amount of salt and water in their bodies

-All fresh water animals

-All vertebrates

-The Vertebrate Liver

-Large organ in the abdominal cavity

-Capillaries on the intestines

-These go directly to the hepatic (liver) portal vessel

-Two capillary beds in series is called a portal system (unusual)

-Food rich blood from intestine goes from the intestine and is processed

in the liver

-High glucose concentration -> liver converts food to glycogen

-Low glucose concentration -> liver converts glycogen to glucose

-Keeps blood sugar level (glucose) leaving the liver constant

-Liver also produces nitrogen waste from protein consumption

-Deamination - removal of amino group -NH3+

-Can be converted to uric acid, ammonia, urea, for elimination

-More toxic substances require more water loss from processing

-Nitrogen waste that insects produces is eliminated in feces (most

successful species on earth, number and variety of environments)

-Osmoregulation and Nitrogen Excretion

-Kidneys

-Outer section is called the cortex outer section is called the medulla

-Function unit are called nephrons

-Glomerulus knot of capillaries that fits into the nephron

-Small molecules capture in the bowman's capsule

-This is called filtrate

-Filtrate travels through nephron

-Second capillary bed: peritubular capillary

-Filtrate is collected here

-Second of three portal systems

9/26/16

-Anolis Cristatellus

-Tree dwelling lizard

-Widespread in low lands

-Anolis Gundlachi

-widespread, mountains, shaded forests

-Used lizard models to determine temperature

-Placed in trees and on the ground at random

-Measured for 2 days

-For each species they sampled at low elevation (warm) and high elevation

(cooler)

-Sampled during August and January

-Metabolic Rates of Animals

-Food + O\_2 -> ATP + nutrients + C\_O2 + Nitrogen Wastes + Heat

-Number of food molecules processed per time

-02 consumption is usually used to measure metabolic rate

-Resting (basal/standard) metabolic rate

-RMR is a volume of O\_2 consumed per unit time.

-Symbol is Vdot\_O2

-If an ectotherm is not thermoregulated its Tb will increase as Te increases

-Endotherms (humans) lose heat to the outside world

-At low environmental temperature metabolic rate is increased

-Endothermy is expensive

9/28/16

-Integration

-Nervous System

-Collects information inside and outside the body

-Processes or integrates information

-Responds to information

-Afferent: collects information, transfer it to the CNS

-Central Nervous System: which integrates it

-Efferent/Effectors: acts on CNS instructions

-Neuron

-Sensory, motor, CNS neuron

-Cell body region that has the nucleus

-Dendrites extension of the neuron that collects information and carries it to the cell body

-Axon transmitting part that carries information out of the neuron through the axon terminal (to the next neuron

-Sensory Neurons

-Usually have dendrites pointing in one direction (direction of information)

-Interneuron (CNS)

-Have wondering/collecting dendrites

-Motor neurons

-Carry information form the CNS out to cells that illicit a response

-Supporting Cells

-There are various types of supporting cells:

-Neuroglia (glia cells) associated with cells from the CNS

-Regulate interstitial fluid around the neuron

-Provide nutrients to the neuron

-Eliminate wastes

-Appear to provide a framework through which the neuron will grow

-Schwann (Sheath) Cell

-Specialized cell that grown around the axon of motor neurons. Coils around the axon (insulating function).

-Arranged down the length of the axon

-Na+ high outside, K+ high inside

-Anions high inside the cell

-Cell membrane is polarized, with negative ions inside (anions) and positive outside (sodium)

-The membrane is permeable to Na+ and K+

-K escapes out and Na comes in through voltage gated channels

-The membrane is never permeable to the anions

-Na/K pump uses ATP to exchange Na and K. Pushes Na out and K in.

-These pumps maintain ion gradients

-Inside of the membrane is -70mV (resting)

-Action potential peaks at ~+30 mV

-On the way down there is a slight hyperpolarization then it returns to the resting potential

-As Na enters the cell the voltage in the cell rises. Once the threshold potential is reached more Na channels are opened and more Na enters the cell

-Once the voltage is high enough the inactivation gates will close

-Once the voltage is high enough the K+ ions will leave the cell

-Outflow of K+ results in decrease in the charge, until the inside of the cell is slightly hyperpolarized

-Na open, Na flows in, then Na gates close, K channel open, K floods out, charge decreases (hyperpolarized first) back to resting

-Charge is resorted but there is K outside and Na inside

-The Na/K exchangers expends energy to get back to the original resting state ion concentrations (Na out K in)

-Travels down the axon

-Self propagating wave, as soon as there is an AP at the base of the axon, that AP will generate one a bit further down, all the way to the axon terminal. This costs the animal ATP via the Na/k pump.

-An AP is an all or none response. No such thing as a strong or weak AP (is the threshold reached?)

-Speed of transmission is faster in a wide axon than a narrow one

-These control emergency responses for example squid ink cloud

-Strong stimuli cause the axon to fire more frequently (more APs)

-Strong stimuli active more nerve cells

-At the end of the axon there is a chemical synapse

-Gap between the axon terminal of one and the dendrite of another cell

-Neurotransmitter chemicals cross this gap

-When the AP gets to the terminal it causes an uptake of Ca+ and cause the vesicles to moves to the dendrite of the next cell. Vesicles fuse to the membrane and bind to the next cell

9/30/16

-Sensory Input and Integration

-Collect information from internal and external world

-Reception of the signal (ex. Eyes collect light)

-Transduction is the conversion of signal energy to action potential

-Transmission of action potential to CNS

-Sensory Receptors have a receptor potential

-This is a graded response

-Visual Receptors

-Ocelli receptors distinguish light and dark

-Ocelli allow animals to detect day length in the context of seasonal changes

-Image forming eyes

-Compound eyes in insects (many lenses)

-Good for detecting movement not great for images

-Camera eyes are single lens eyes good for forming picture. Vertebrates and several invertebrates.

-Light travels through the pupil and hits receptor cells and specialized neurons on the retina.

-Chemical changes occur when struck by light

-Sound Receptors

-Most invertebrates do not have ears

-However, most insects have good sound receptors

-Vibrating bones in the ear amplify pressure waves

-When the staple vibrates the oval window fluid in the cochlea vibrates too

-Bending of hair cells is the transduction that causes an action potential

-Vertebrates have afferent nerves that carry information to their nervous system and efferent nerves that carry information away from the CNS

-Ganglia – nervous tissue that do some integration

-Somatic system – voluntary actions

-Autonomic system – “housekeeping functions” breathing rate, dilation of blood vessels, heart rate

-Sympathetic nervous system – excitatory

-Parasympathetic nervous system – inhibitory