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 tissue 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 eliminatted.

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 absorption

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 (further 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 produce 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 / 2 ATP

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\_2to 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 either 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 chamber

-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 value 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 cell membrane

-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 heart 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 stiff 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 exchange 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 by 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 it’s 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 responsive 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 gets 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 addition 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 produce 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

10/3/16

-Somatic nervous system is used for conscience control

-Reflex arc is a hardwired response system but is made of nerves of the somatic nervous system

-All integration takes place in the spinal cord in the reflex arc

-Effector System (IGNORE CHAPTER 43)

-3 Types of Skeletons

-Hydrostatic Skeletons: fluid skeletons

-External Skeletons: exoskeletons found in arthropods, jointed, muscles inside, difficult to grow must shed skeleton, complex movements

-Endoskeleton: vertebrates, complex movements, can grow

-Bone

-Matrix of bone has collagen fibers, proteins, Ca++

-Marrow: blood cell production

-Cartilage

-Matrix: collagen fibers and some polysaccharides

-Forms primary skeleton of the embryo

-Smooths actions of joints

-Flexible structures

-Tendons

-Connect to muscle to bone

-Ligaments

-Connect bone to bone

-Both tendons and ligaments are made of similar dense connective tissue. Matrix is primarily collagen fibers in parallel.

-Muscle: not a connective tissue, no matrix

-Contractible tissue

-Smooth muscle: stomach, intestine, blood vessels

-Controlled by autonomic system

-Cells are thin, long, and flexible

-Skeletal muscle: controlled by the somatic nervous system

-Arranged in bundles of bundles

-Cardiac muscle

-Found in the heart

-Mixed properties: controlled by autonomic nervous system, fibers look like skeletal

-Flexor muscle: brings body part closer to the mid line of the body

-Extensor muscle: brings body part further from the mid line of the body

-Nueromuscular junction: synapse between neuron and muscle cell

-All or none response per cell

-Whole muscle has a graded response

---------------------------------------------------------------------Exam 2

-Endocrine System

-Integuation is controlled through the circulatory system

-Endocrine Glands = ductless glands

-Hormones – chemical signals produced by endocrine glands

-Hormones are interpreted by target orangs which or orangs that have cells that bind hormones and provide a very specific response to the hormones

-Basic Principles

-Hormones function at low concentration

-The specificity of the response varies with the target organ

-Antagonistic hormones provide very fine control

-Functions of the Endocrine System

-Maintenance – regulation of body chemistry and physiology (ph, salt concentrations, etc.)

-Control developmental effects (maturity)

-Reproduction

-Role of the Hypothalamus

-A brain structure with endocrine function

-Connected to a two part galled called the pituitary

-Posterior Pituitary

-ADH

-Oxcytocin (involved with giving birth) mammary glands and uterine contractions

-Anterior Pituitary

-Portal System between the hypothalamus and the anterior pituitary

-Release other hormones based on info from the portal system

-Growth hormone, Melanocyte Stimulating Hormone, Endorphins

-Hypothalamus -> Anterior Pituitary –> Thyroid -> Systemic

-All have endocrine function

-Thyroid hormones stimulates aerobic metabolism

-System of negative feedback – a system in which a change in a physiological variable triggers a reaction that counteracts the change

-The presence of thyroid hormone in the blood inhibits the production of thyroid stimulating hormone in the pituitary

-Also negative feedback in the hypothalamus – inhibits thyroid releasing hormone

-Other Endocrine Glands Not Under Control of the Hypothalamus

-Hormones and digestion

-Gastrin - secreted by cell in the pyloric (upper) region of the stomach. Food stimulates the production of gastric juice.

-Secretin – stimulates production/release of enzymes and bicarbonate by pancreas

-Stomach produces cholesystokinin

-Stimulates the release of bile from the gall bladder and pancreatic enzymes

-Slows passage of food through the stomach (after eating a fatty meal)

-Pancreas

-Enzyme producing cells pour products into the duct of the small intestine

-Insulin and glucagon -> sugar metabolism

-Insulin – reduces blood glucose concentration (beta-cells)

-On muscle, insulin increases uptake

-In the liver, reduces conversion of glucose to glycogen

-High blood glucose leads to excretion of glucose in urine. Also excrete more water to flush solutes. This leads to dehydration and excessive thirst. IN the disruption of glucose metabolism, the body burns fats as an energy source leading to rapid weight loss. -> Diabetes

-Insulin/glucagon (alpha-cell) production is under both positive and negative feedback control

-Blood glucose regulation is important for the brain (used an an energy source)

-Adrenal Medulla (interior)

-Produces adrenaline and noradrenaline, functions like sympathetic nervous system (increase heart rate, etc.)

-Adrenal Medulla is the second neuron to the brain

-Parathyroids

-4 gland that sit on top of the thyroid

-Parathyroid hormone increase blood Ca++ concentration by decreasing renal excretion for Ca++, increase the release of Ca++ from bone, and increases the uptake of Ca in the intestine

-One small molecule with lots of effects

-Antagonistic molecules - calcitonin produces by the thyroid, decreases the release of calcium from bone

10/10/16

Frog Metamorphosis:

Eggs -> tadpoles ->frogs

-Destructive Changes

-Tail Reabsorbed

-Gills Resorbed

-Mouth Altered

-Dig System Altered

-Constructive

-Limbs

-Lungs

-Dig System

-Thyroxin causes these change at any stage of development

-Development of Sexual Characteristics

-Induced by steroid hormones

-Adrenal glands testes, ovaries

-7-10 week old fetus

Male -> female genitalia

-Develop male structures in the presence of testosterone

-Develop female structures in the absence

-Females Develop oocytes

-Hormonal Initiation of Puberty (reproductive maturity)

-Hypothalamus Releases GnRH -> Anterior pituitary -> FSH and LH

-negative feedback loop

-Gonads (ovaries and testes)

-Testosterone has a positive feedback look with the testes

-Testosterone and FSH lead to sperm cells

-Testosterone also stimulates secondary sexual characteristics (hair, voice, muscles, maturation of reproductive system)

-LH and FSH in females

-Target ovaries -> create estrogen and progesterone

-Estrogen stimulates secondary sexual characteristics

-Lining of the uterus called the endometrium

-Menstrual Cycle

-28 Day cycle

-4 days of flow, at end of flow lining of uterus is thin

-FSH is low LF low

-Follicular phase (days 4 -12)

-FSH start growth of several follicles and only the dominant develops into an egg

-Increased ovarian hormones induce increased thickness in uterine lining

-Ovulation - release of the egg from the follicle

-Accomplished by estrogen, GnRH and hypothalamus in feedback loop

-After a follicle releases and egg cell it changes and is called a corpus luteum

-Corpus luteum produces another surge of estrogen and progesterone

-The hormones maintain the glandular epithelium

-Allow a fetus to implant

-Progesterone has an inhibiting effect on the hypothalamus

-Negative feedback

-New follicles will not develop

-Birth control inhibit hypothalamus, prevents that maturation of the follicle

-Other Mammals

-Periodical

-Changes at the time of ovulation

-Changes in behavior

-Females are only receptive to males at the correct point in the cycle

-Reflex ovulation

-The Hormonal Control of Pregnancy

-Implantation in the oviduct is dangerous

-No contact between fetal and maternal bold supply but molecules cross

-Embryonic part of the placenta creates a hormone called human chorionic gonanatropin HCG

-Preserves corpus luteum

10/12/16

-Gametogenesis

-Origin of sperm and eggs (gametes)

- Spermatogenesis

-Sermatogonium (diploid 2N = 4)

-produces 4 sperm

-Primary spermatocyte (diploid 2N = 4)

-Secondary Spermatocyte (haploid)

-Spermatid(haploid)

-Sperm (haploid)

-Sperm Anatomy

-Head, mid piece, tail

-Head: nucleus and acrosome (borough into egg)

-Mid piece (mitochondria/energy source)

-Tail (flagella)

-Oogenesis

-Oogonium (diploid)

-produces 1 egg

-Primary oocyte(diploid)

-Secondary oocyte (haploid)

-Egg released from ovary

-Ootid(haploid)

-Egg (haploid)

-Egg Anatomy

-Much larger than sperm

-Nucleus: abundant in rRNA (ribosomal RNA) and mRNA (messenger RNA)

-Yoke

-Plasma membrane

-Vitaline coat

-Fish eggs may have an extra membrane as a barrier to the uptake of water

-Terrestrial animals may … due to dehydrating properties of air

-Fertilization

-Sperm penetrating egg

-External Fertilization

-Spawning: synchronization of reproductive activity of males and females indicated by environmental factors or courtship

-Internal Fertilization

-Male and females must have mature gametes

-Many animals use hard shell eggs and must use internal fertilization because the egg has to be fertilized before the eggs are shelled

-Sperm activation: Na ions flow into egg membrane

-Once sperm enters egg undergoes cortical reaction

-Enzymes open up a space in the egg membrane and vitaline coat pulls away from the plasma membrane

-Vilatine cost is now called fertilization membrane

-Plasma membrane is renamed hyaline layer

-Fast block to polyspermy (electrochemical change)

-Rise of fertilization membrane is the slow block to polyspermy

10/14/16

-Cleavage

-DNA Replication

-Membrane Production

-Protein Synthesis (mRNA) in egg

-Coelomate Animals

-Radial Cleavage

-Deuterostomes

-First and second cleavage planes are vertical

-Creates 4 cells stacked on top of 4 other cells

-Blastocoel

-Spiral Cleavage

-With each cell division the embryo twists a quarter turn clockwise

-No blastocoel

-Gastrulation

-Reorganization of cells

-Three cell layers

-Endoderm (Yellow)

-Mesoderm (Red)

-Ectoderm (Blue)

-First invagination is the call the primitive gut

-Deuterostome

-Radial Cleavage

-Mesoderm form cells at roof of gut

-Coelom pinched off from mesoderm

-Blastopore

-Protostomes – mollusks, annelids, arthropods

-Spiral cleavage

-Mesoderm forms from cell near the blastopore

-Coelom forms as a split in the mesoderm.

-Blastopore forms the mouth

-Amphibian Egg

-Polar egg

-Gastrulation forms at the grey crescent

-Migration of cells around the sphere establishes tissue layers

-Development in Mammals

-Maternal and fetal blood supplies don’t mix

10/19/16

-Pants

-Growth of plants is modular. There are multiple repeating units.

-Autotropic

-Monocots – 1 seed leaf

-Eudicots – seed leaves

-Shoot System

-Collects energy

-Manufactures sugars

-Anchors plant

-Sexual reproduction

-Steam is the main supporting structure

-Leaves attach to stems at the petiole

-This point is called a node

-Terminal bud leads to primary growth

-Lateral buds lead to branching

-Monocots have net like veins

-Dicots have parallel veins

-Plant Cells and Tissues

-Cell wall made up of parallel fibers

-Plant cells only elongate

-Water Conducting Cells

-Dead, in xylem, long thin pipe

-Sieve Tube Members

-Found in phloem (sap-carrying tissue)

-Plant Tissues

-Dural tissue (like skin)- epidermis, waxing cuticle, root hairs, stoma

-Vascular Tissue – xylem and phloem

-Ground Tissue

-Plant Growth

10/21/16

-Secondary Growth requires the plant to grow wider

-Oldest part of the tree is in the center

-Sapwood is alive

-As the tree gets wider the wood accumulates in the center of the trunk and the phloem is added to the outside

-Old phloem please of the tree

-Cork Cambium produces new cells to the indie and outside of itself. Dead cells to the outside and cortex cell to the inside.

-Water and Mineral Uptake

-Stele vascular cylinder in the center

-Photosynthesis in the leaves

-Concentrated soil minerals can enter plant through diffusion though most mineral require active transport for uptake into the pant. Allows plant to be very selective about what enters is vasculature.

-Epidermis -> root cortex

-Symplast water uptake

-Plasmodesmata are opens in the cell walls. Allow certain amount of contact with cell membrane of adjacent cells.

-Allows for regulation

-Intracellular pathway

-Apoplast

-Hydrophilic action (like a sponge)

-Moves through cell wall without ever passing through the living part of the cell. Until it gets to the inner most cell in the root cortex.

-Hits waxy later in the endodermis. Then it leaves the cell wall and crosses membrane of living cell.

-Apoplast is completely non-selective until it gets to the endodermis.

-Extracellular pathway.

-Transport in Xylem

-Plant gets C02 from stoma under the leaves

-After photosynthesis 02 and water are produced as a byproduct

-Plants transport water from soil all the way up the tree with no pumps

-Water Potential (no calculations) - a measure of the tendency of water to flow from one place to another

-Water flows from low osmotic areas to high osmotic areas

-High water potential = low osmolality

-Low water potential = high osmolality

-Increase pressure increase water potential

-Increase in solute decrease water potential

-Cohesion vs adhesion?

-Cohesion makes water molecules flow up the xylem

-This force is called transportation

-This is, the water passing through plants and out though the stoma

-Helps bring water in the roots by lowering water potential in the stele

10/24/16

-Transport in Phloem

-Carry Sap/sugar/photosynthesis

-Source Sink Transport

-Source: Organ where sugar is produced by photosynthesis or by the conversion of stored starch (usually leaves/roots)

- Phloem sap moves by pressure flow

-Plant Reproduction

-Modes of Reproduction: Asexual and Sexual Reproduction

-Sexual Reproduction 🡨 Angiosperms

-Alteration in Generations

-Sporophyte 🡪(meiosis) Spores 🡪(mitosis) gametophyte (either male or female/haploid) 🡪(mitosis) haploid gametes 🡪 Games encounter each other 🡪(fertilization) 🡪 zygote

-Development of male Gametophyte

-Development of Female Gametophyte

-Pollination and Fertilization

-Pollination: wind pollination (trees), animals (insects, birds, bats)

-Plant gives up nectar for animals to feed on in exchange for fertilization

-Double Fertilization

-Production of a zygote and endosperm

-Create a triploid cell called an endosperm

-The endo sperm is a nutrient store for the embryo

-Angiosperm seeds

-Zygote 🡪 produces polar embryo by mitosis and produces the suspensor for nutrient delivery 🡪 heart shaped embryo 🡪 Ovule becomes the seed coat to resist environmental stressors

-Beans are eudicots

-Corn species are monocots

-Fruit Development

-Fruit: mature ovary (don’t worry about fruit)

-Color/odor attract animals as dispersal agents

-Mutually beneficial

-Not all fruits are fleshy/soft

10/26/19

-Germination

-Inhibition

-Mobilization of …

-Emergence of radicle (root)

-Emergence of leaves

-Monocots have two structures that emerge at either end of the seeds

-Control Systems

-Animals

-Nervous/Endocrine

-Plants

-No locomotion

-Modular Growth

-Systems for regulation of growth and development

-No Nervous System but produce lots of hormones

-Chemical signals produced in certain tissue and influence other tissue

-Function at low concertation

-Have multiple effects (cell division, cell elongation, cell maturation, cell

death)

-Plants bend to face light, can sense light, direct growth of whole shoot

-Chemical (auxin) on shade side of the plant causes it to grow toward light

-Auxin – chemical that promote stem elongation

-Growth hormone

-Produces by actively growing tissue in the apical meristem (site of cell division)

-Acts in zone of elongation behind apical meristem

-Root cells are more sensitive than shoot cells

-Auxin = Indole Acetic Acid – IAA- or IAAH

-Presence of IAA- stimulates pump to pump H+ ions into the cell wall acidifying

-Cytokinins

-Name refers to cytokinesis (cell division)

-Group of hormones

-Produced in growing roots, embryos, and fruit

-Transported in xylem sacks

-Interacts with auxin

-When auxin >> cytokinin the callus produces root

-When Auxin << cytokinin the callus produces shoot

-Coordinates the growth of roots and shoots together

-Interplay between these two hormones has an impact on apical dominance

-Growing tip at the top of the plant produces auxin which inhibits the growth of lateral buds

-Cytokinin stimulates the growth of later buds

-Gibberellin calls of hormone that stimulates primary growth in stems and leaves

-Stem elongation (bolting puts of giant inflorescence – flower stalk)

-Also affect fruit production in interaction with auxin

-Germination

-Ethylene (hormone)

-Gaseous hormone

-Main effect is senescence

-Stimulates sweetening of fruit and loos of chlorophyll

-Positive feedback loop

-Leaves leaf abscission (dropping of leaves in the fall)

-Photochrom system

-Seasonal/day-night regulation kind of like a light switch

10/28/16

-Scientific Method

-Supporting Belief Systems

-Bernard Cohen

-Tenacity (sports team example)

-Authority (great thinker/spell checker)

-Intuition (the world is flat)

-Science – reflective inquiry / skepticism

-A hypothesis must be falsifiable

-Implicit Assumptions of the Scientific Method

-Scientist must be impartial

-All the facts are known

-Experimental results are both clear and reproducible

-Evolution Barriers to Acceptance

-Politics

-Occurs over long time scales

-Not everything is amenable to experimentation

-Pre-Darwinian Conception

- Ideal Types

-Natural History

-Ideal Types -> Prevalent until 18th century in Europe

-Aristotle 🡪 expanded idea and made a ranking of objects

-Creationist Thought

-17th Century – Scala Naturae (The Great Chain of Being)

-Spiritual World 🡪 Humans (Pope, church officials, King, aristocrats, merchants, serfs, savages) 🡪 Invertebrates 🡪 Plants 🡪 Inanimate Objects

-Allowed for oppression of lower order people

-Linnaeus – worked for the greater glory of God, wanted to outline details of God’s creation

-Thought Earth was approx. 6,000 years old

-Late 18th century 🡪 Early 19th century

-Buffon

-Proposed vestigial structures

-Calculated the earth must be more than 100,000 years old

-Cuvier

-Comparative anatomy

-Noticed layer rocks filled with fossils

-Fossils in the deeps layers were most dissimilar to animals alive today

-Upper layers were closest

-Developed the theory of catastrophism layers made by great floods

-Early Evolutionary Thought

-Geology (the study of the earth’s surface)

-Great age of the earth

-Cuvier made this idea palatable with catastrophism

-Uniformitarianism – John Lyell (major geologic structures like the Grand Canyon were produced by the same forces we observe today like erosion)

-This idea was coupled with the idea of gradualism (idea that small changes happening over a long time can create large things)

-Stratigraphy – study of fossil contain layer

-Early Biological Evolution

-Lamarck / Erasmus Darwin

-The principle of use and disuse (wrong)

-Inheritance of acquired characteristics (wrong)

-Change occurs from one generation to the next (correct)

-Change is brought about by environmental pressures (correct)

-19th Century Evolutionary Theory

-Concepts of Darwin’s Theory

-Most organisms produce more offspring but populations do not expand rapid

-This implies competition for limited resources

-Organisms in same species exhibit variation

-Knew that these features could be passed along to the next generation

-These features gave some animals and edge for survivability

-Good characteristics become more common in subsequent generations

-Did not know how new variations arise or how it was passed to the nect

Generation (no concept of genetics)

-Published On Origin of Species in 1859

-Mendel published genetics in 1865 in German not translated into English until

1900

-Darwin was missing evidence

-Natural Selection

-Purely materialistic

-Evolution Occurred in populations not individuals

-Evolution is a multifactor process – some factors create the variability and other factors decide if that variability is useful or not

-Evolutionary Theory Since Darwin

-After the Rediscovery of Mendel’s Work

-Blending of Darwin/Mendel/Others ie. Other biology/paleontology

-Levels of Study

-Microevolution

-Macroevolution

-People who studied these did not work together much

-1980’s – Evolutionary Developmental Biology (evo-devo)

-Molecular tools to study changes

-Hox Genes in Snakes

10/31/16

-Darwin: recognized inheritance/knew nothing about genetics

-Genotype: genetic variance that an individual has in all its cells

-Phenotype: the expressed characteristics

-Darwin was interested in the morphological phenotype

- (Genotype 🡨🡪Environment) 🡪 Phenotype

-Environmental factors influence phenotype

-Phenotypic Variation

-Continuous (Quantitative) Variation: variation by degree

-Polymorphism (Discrete or Qualitative Variation): ex. Blue or pink

-Non-Mendelian Variation

-Age Variation (ed. larva)

-Seasonal Variation (ex. fur)

-Social variation

-Neurogenic variation (variation caused by the nervous system, ex. color change)

-Traumatic variation

-Two Experimental Approaches

-Transplant Experiments: more individual to a different environment and observe, test

the effects of environmental differences

-California milfoil plant: cline (regular pattern of variation that follows a

geographic gradient) in the height of plants

-Tall plants at low elevation, short plants at high elevation

-Collected seeds at various locations and grew the plants at different locations on

the mountain. Place of origin of the seed had an impact on the height of the

plant.

-Breeding experiments: Artificial selection

-Speed an endurance in mice responded to artificial selection and likely have a genetic

Basis

-Observational Approaches: Researcher makes measurements in nature and tries to associate characteristics with environmental factors

-External morphology (snails)  
 -Enzyme variability

-Gel Electrophoresis

-Enzyme variation: for many spices 25-50% of genes were polymorphic

-For many individuals, 5-15% of genes were heterozygous (different version of gene

from each parent)

-Population genetics: the math and statistics of evolutionary processes

-Predict events based on stats, use null hypotheses framed in terms of algebra

11/2/16

-Alleles -Different genetic variants at a locus

-Population Level

-Population is a group of individuals of the same species living together and can possibly interbreed

-Individuals have a genotype – the genotype is the combination of alleles that that individual carries (mostly diploid individuals 2N – 2 alleles/locus)

-Haploid Gametes (1N) 1 allele/locus

-Gene pool is all the alleles present in the population

-Alleles come together to make the genotype

-Diploid Organism 2 alleles / locus

-C^R C^W 🡪 C^R C^R or C^R C^W or C^W C^W

-Homozygous – same allele

-Heterozygous – different alleles

-Genotype frequencies

-D = C^R,C^R

-H = C^R,C^W

-R = C^W,C^W

-Frequency of C^R = frequency of p = #p//#p+#q

-Frequency of C^W = frequency of q = #q//#p+#q

P = freaq C^RC^R + ½ freaq C^R C^W = D + 1/2H

Q = R + 1/2H

P + Q = D + 1/2H + 1/2H + R

1. Recombination (crossing over)

2. Independent assortment of genes

3. Act of fertilization combines genes from two parents

-Microevolution is a change in a-llele frequency over time

-Does all the shuffling of genetic material in sexual reproduction cause microevolution?

1. Diploid female and male

2. D,H,R and pq are the same in males and females

3. p + q in gametes

4. All males and females have equal access to each other as mates/ experience random mating

5. All males and females produce the same number of offspring

Freaq C^R C^R = D

Freaq C^R C^W = H

Freaq C^W C^w = R

Freaq C^R = P

Freaq C^W = Q

-Probability of the union of two independent events is equal to the product of their separate probabilities.

P^2 + 2PQ + Q^2 = 1

P` = D` + ½ H`

P` = P^2 +1/2PQ

P` =(P+Q)P

P` = P

-Random shuffling does not cause allele reacquires to change

-Once allele freakiness reach genetic equilibrium both genotype and allele frequencies do not change

-------------------------------------------------------------------------------------------------------------------11/9/16

-HW Assumptions

-Panmixias – random mating

-population size is infinite

-No mutations

-No Migration

-No differential reproductions by genotype (survival, fecundity)

-Mutation is and change in the structure of DNA

-3 Bases 🡨🡪 Codon

-64 Bases

-21 Codons

-Redundancy in the genetic code – several codons can specify a single amino acid

-Misuse Mutation– different protein

-Nonsense Mutation- changes sense codon to stop codon

-Silent mutation – sense codon to codon for same amino acid

-Frameshift Mutation- once base pair is added or removed from the string and the reading frame in shifted

-Gene Flow – the movement of novel genetic material from one population to another

-Occurs through the process of migration or dispersal

-Gene flow makes two populations genetically more like one another

-Natural Selection – differential reproduction of genotypes

-Phenotypes that experience natural selection (lethal allele)

-Directional selection shifts the men value of a trait

-Commonly used by farmers

-Stabilizing Selection – favors the mean phenotype, preserves mean eliminates extremes (most common)

-Disruptive selection - polymorphism (two or more viable traits)

-Genetic drift- random changes in allele frequency

-Important in small populations

p = .1

q = .9

Frequency: C^r C^r = p^2 = .01

C^r C^w = 2pq = .18

C^w C^w = q^2 = .81

-Effects of Genetic Drift

-Loss of rare alleles

-Decrease in the genetic diversity

-Decrease in “evolutionary potential”

-Ecological Circumstances Promoting Genetic Drift

-Continuous

-Populations that are always small

-Intermittent

-Sudden decrease in populations size

-Founders effect that is an individual founding a population

11/14/16 – Lecture 26

-Speciation: process of species formation

-Variation between populations can lead to a separation of gene pools

-Separation of a gene pool is critical for speciation

-Species- group of population that can interbreed and are reproductively isolated from other such groups

-Speciation is a process

-Allopatric Speciation: Geographic speciation, living in separate places

-Stage 1: Geographical isolation

-Causes the elimination of gene flow

-Isolation is a necessary but not sufficient condition

-Stage 2: Genetic Divergence of the Isolated Population

-Experience different mutations

-Different patterns of natural selection

-Different amounts of genetic drift

-Large geographical range is split in two potentially causes this

-New species arise most often in peripheral isolates

-Coming back together is called secondary contact

-Interbreeding 🡪 no speciation

-Interbreeding only in a narrow area of overlap

-No Interbreeding 🡪 Speciation is complete

-Adaptive Radiation (Darwin: finches on Galapagos islands)

-Sympatric Speciation: speciation between populations that are living in the same place

-Phytophagous Insects- host specificity

-Rhyolites – apple maggot Hawthorne

-Abrupt Speciation: Speciation that occurs from one generation to the next through polyploidy

-Polyploidy: having more than the usual number of chromosomes (40% of angiosperms)

-Missed this part of class review in book

-Reproductive Isolation

-Sexual Selection: Mallard/Pintail male head

-Reproductive Character Displacement: the traits of two species are similar where they are allopatric but different where they are sympatric – Austrian frog call example