

BIOLOGY 115 EXAM 2 REVIEW

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CHAPTER 7 - ORIGINS OF LIFE & PRECAMBRIAN EONS

- Fossilization happens best when oxidative decomposition does NOT occur. Exposure to oxygen can rot the living material.
- **Paleontology** is the science of fossil collecting and deducing what life was like long ago. The scientific skill comes in recognizing shared evolutionary history from **convergent evolution** (If similar selective pressures have been applied to two species, then they will have similar adaptations)
- Our Solar System formed from a gas cloud 4.6 billion years ago, molecular oxygen was NOT present, which slowed breakdown of all molecules.
- **Self-replicating** organic molecules appeared, formation of **amino acids** is important in evolution of self-replicating life because it makes proteins that catalyze chemical reactions.
- **RNA** can perform enzymatic activity, it can code for proteins and catalyze chemical reactions. It has a high rate of mutation because it has no second strand to check first strand's sequence. High mutation rate = ability to rapidly evolve. **DNA** evolved as an adaptation to increase genetic stability.
- **Cell membranes** protect the genetic material from unwanted reactions with outside world.
- First cells were **anaerobic** using energy from volcanic activity or exothermic reactions to power the energy requiring reactions necessary for reproduction.
- **Cyanobacteria** are **photosynthetic**, producing carbohydrates from sunlight, carbon dioxide, and water. *Cyanobacteria were first source of molecular oxygen* → molecules broke apart faster than before.
- Oxygen allowed for **aerobic metabolism**, which evolved as a way to eliminate oxygen before it could damage cell because it was toxic to anaerobic bacteria and to all archaea. Archaea was pushed to extreme environments.
- **Stromatolites** are layers of sedimentary rock created by congregation of cyanobacteria.
- **Eukaryotic Cells** evolved and have chromosomes inside a nucleus. **Mitochondria** inside cell looks like older aerobic purple bacteria. **Chloroplasts** look like cyanobacteria. Eukaryotes acquired these organelles by engulfing bacteria. *All living plants are descended from an alga that engulfed a cyanobacteria.*
- **Sexual reproduction**, exchange of genetic material, increased chance for new combinations.
- 1.2 bya exposed land was pushed together to form supercontinent **Rodinia**. Rodinia then broke into two continents - **Laurentia** and **Gondwana**.
- 600 mya **soft-bodied animals** (no shell or tough skin) appeared and were able to rapidly

respond to stimuli and were capable of quick and complicated movements. They had to eat other things for energy (heterotrophy).

- **Vertebrates** evolved notochords supported by a series of paired cartilaginous structures.

CHAPTER 8 - PALEOZOIC ERA

- 540-440 mya **Jawless Fish** evolved, and had teeth embedded into their mouths. Marine ancestors of **arthropods** (have segmented bodies with jointed legs and have **exoskeletons** protecting their bodies) also evolved.
- This increase in the diversity of life is called the **Cambrian Explosion**. **Nonvascular plants** also evolved in mud where ocean and land met.
- Concentration of O₂ increased to the point where it started moving from water into the air, which reacted with UV light to form ozone.
- **Spores** with with vascularization to move fluids developed.
- Problems with living out of water
 - Buoyancy of water can support huge bodies. This buoyancy wasn't available on land to fight gravity.
 - New ways of exchanging the metabolic molecules (CO₂ and O₂) between organisms' cells and air, instead of water, had to evolve.
 - UV light can damage outermost layer of organisms.
 - All living things are made mostly of water, so the diffusion gradient favors water molecules evaporating from organisms into the air.
- Loss of critical Equatorial coastal habitat caused the first mass extinction event (MEE) of life on Earth.
- Dramatic decreases in species diversity are major *punctuation* points. However, mass extinction events open niches for survivors to fill via mutations - **adaptive radiation**. Competition between surviving species to fill niches causes **niche partitioning** to avoid **competitive exclusion**. This leads to specialization of species. A **specialist** is an organism that has a *narrow* niche: it is really good at living in one certain way. A **generalist** is the opposite, it has a *broad* niche. Generalists are ok at many things, but not fantastic at one thing. Generalists do well until specialists fill all the niches in the community.
- Fully **terrestrial vascular plants** evolved and have roots to acquire water and nutrients from sediments. They also have vessels to transport nutrients. Plants rely on hydraulic pressure to fight gravity.
- **Wingless hexapods** evolved from aquatic arthropods and were first animals to live on land. Has a head, a thorax, and an abdomen. The wingless hexapods then evolved into **insects** and later arachnids.
- Fishes with **jaws** (developed from calcified cartilage support structures called gill arches) called placoderms evolved. From these fish the **cartilaginous fish** (sharks and rays) and **bony fish** evolved.
- Lungfish and mudskippers have modified swim bladders, terrestrial vertebrate lungs develop from same cells that developed swim bladders.
- **Amphibians** evolved from bony fish with swim bladders.

- **Stiff-winged insects** evolved. Stiff because their wings cannot be folded over the back of the insect.
- 360 mya an unknown catastrophe led to the second MEE. Insects with **folding wings** evolved at this time, and some insects showed signs of metamorphosis.
- 320 mya, **reptiles** evolved from amphibians. The **tough skin** and **amniotic eggs** with calcified shells of reptiles were major advances.
- **Cones** to hold **seeds** developed in plants. However, plants reproducing by spores still dominated.
- Reptiles were classified into **synapsids** (one hole in cranium and would give rise to all mammals) and **diapsids** (two holes and would give rise to dinosaurs, crocodiles, lizards, and snakes).
- Mammals are only living amniotic vertebrates without water-saving kidney adaption and water a lot of water excreting waste nitrogen
- 280 mya all land masses came together to form Pangea. Dry land stretched from pole to pole cutting off global ocean currents. This was the third MEE (largest). Could be due to extra-terrestrial impact or result of continents smashing together. Volcanic activity increased.
- Order of Adaptations: Swim (aquatic) → Walk (terrestrial) → Fly (flight)

CHAPTER 9 - MESOZOIC ERA

- 250-200 mya, Reptiles started returning to the sea to avoid competition on land. Diapsid pterosaurs evolved to fly by stretching out their fourth fingers to support a skin flap between arms and bodies.
- Dinosaurs beat mammals at radiating into open niches. They are the *most successful group of vertebrates to ever walk on land or fly in the air*.
- Difference between mammal-like reptile and mammal: Mammals have even more specialized teeth in their mouths than their synapsis ancestors. Egg-laying mammals evolved with fur and milk for their young.
- Insects have a complete metamorphosis with different larval, pupal, and adult bodies.
- In Jurassic Period (200-146 mya) tall conifer forests covered the land.
- First dinosaurs with feathers modified for flight appeared. Feathers evolved as an external covering for insulation. Mutations and natural selection then favored longer feathers and skeletons modified for flight.
- Amphibians continued to radiate. Salamanders hunted insects and frogs with their metamorphosis from tadpoles to adults appeared.
- Mammal fossils show similarities in teeth and pelvic bones with modern placental mammals. Placental and marsupial mammals most likely evolved separately from egg-laying mammals.
- **Flowering plants** appeared. *Flowers are one of the most important adaptations in the history of life on Earth*. Metamorphic insects and the flowers they pollinate have ruled the land. Leaves of all grass species contain glass-like particles of silica that rapidly wear down herbivore teeth, grasses are one of the the most dominant plants.
- Plants evolve adaptation to make it hard for animals to eat their leaves by making them

toxic or very tough to chew. Animals in turn evolve adaptations to mitigate the plant defensive adaptations.

- The end of the Age of Dinosaurs came 65 mya with the fourth MEE due to an asteroid.

CHAPTER 10 - CENOZOIC ERA

- Spreading of continents caused immense mountain building, major climate swings, large grasslands emerged. Flowering plants continued to be successful.
- Birds quickly filled niches. Birds lacking teeth out-competed species that had teeth, leading to the extinction of all toothed birds.
- **Primates** are mammals with forwards facing eyes, opposable thumbs digits without claws, and the inability to make our own vitamin C.
- Primate with dental pattern similar to humans and other great apes: 2 incisors, 1 canine, two premolars, and three molars (2:1:2:3) in each jaw quadrant was found. This primate is oldest hominoid, the name given to the group that contains all the great apes, humans, and their extinct relatives.
- 11,000 years ago the rate of species extinction accelerated, this is the fifth MEE and it continues today.
- Humans and our extinct bipedal relatives are called **hominins**.
- Less time in trees and more time on the ground led to **bipedalism**-the ability to walk upright on our rear appendages all the time.
- Bipedalism is not same as upright posture. All apes have upright posture: the head sits on top of spine.
- The difference comes in how hominins and apes *walk*. Apes used their feet *and* their hands. Only hominins use only their feet all the time.
- Adaptations for bipedalism:
 - Back and hips have to be able to support *all* body weight
 - The human spine has alternating curvatures
 - Our lumbar vertebrae are thick and do not allow much twisting. Our pelvic bones are thick and not elongated.
 - Our posterior gluteal muscles are much stronger than our lateral luteal muscles (reverse in apes)
 - Leg bones and muscles are longer and stronger than our arm bones and muscles.
 - Our feet have arches, and our toes are reduced in size and have little ability to grasp objects.
- As one moves up the human phylogenetic tree, the area inside the skull occupied by the brain is larger. At the same time the complexity of tool use and social behavior has increased. Brain size should never be used to judge intelligence.

CHAPTER 11 - INTRODUCTION TO BEHAVIOR

- Behavior is responding to a stimulus-one of the signs of life. *All living things respond to stimuli, therefore all things do behavior*. Behavior can be genetically coded or learned. The ability to modify behavior based on experiences is called **learning**.

- **Ethology** is the scientific study of behavior.
- If a specific response to a specific stimulus always occurs, we say the behavior is **stereotypic**. There are 3 components to stereotypic behavior:
 - **Sign stimulus** - the trigger for the behavior
 - **Innate releasing mechanism** - the part of the organism that is perceiving the stimulus and initiating the response
 - **Fixed action pattern** - the response behavior that always happens as a result of the sign stimulus
- The innate releasing mechanism will be the nervous system. For plants they use a complex endocrine system and hormones do all the work in plants. Bacteria use chemical messenger molecules like cyclic AMP.
- Behavior has two causations:
 - **Proximate** - is the (sign) stimulus that triggered the behavior
 - Ex. cold temperature caused you to put on coat
 - **Ultimate** - is the big evolutionary advantage to the behavior
 - Ex. putting on the coat allowed you to expend less energy trying to maintain a constant body temperature. Less energy spend on thermoregulation means more energy to do other things like courtship and reproduction.
- *“Winning” at natural selection means having more kids and grandkids than others in your population.*
- Vascular plants move via hydraulic system in stems and leaves. More water on one side of stem causes stem to bend towards one side with less water pressure. Hormones released in response the stimulus cause the change in the water pressure. Plant behavior can be categorized by stimuli:
 - **Phototaxis** - movement in response to light. Proximate causation when the plants turn stems and leaves towards light source. Ultimate causation is to optimize photosynthesis.
 - **Mechanotaxis** - movement in response to physical contact. Proximate causation is when plants curl leaves or wilt when touched. Ultimate causation is to reduce exposed parts to herbivores.
 - **Chemoresponse** - is a chemical response to physical contact or damage. Proximate causation is that the toxins require energy to make, so the plant waits until after initial damage to start toxin production. Ultimate causation is that the plants can do more photosynthesis.
- **Learning** is adjusting response after exposure to stimulus. **Intelligence** is the ability to learn and to solve problems and difficulties. **Insight** is the ability to visualize a problem and its solutions. Trial and error learning (**operant conditioning**).
- The **sensitive phase** is the time for learning. Within the sensitive phase is the **critical period** when learning is at its best (young individual absorbs everything).
- An individual’s ability to reproduce is based on its ability to send the appropriate signal to the opposite sex.
- The bachelor males are sexually mature, but not yet **socially mature**.

CHAPTER 12 - COMMUNICATION & TERRITORIALITY

- Behavior needs coordination and coordination happens because of communication. The **functions of communication** are:
 - Warning to predator: aposematic coloration
 - Warning to others: alarm
 - Advice to others: food, social position
 - Advertisement of reproductive condition: courtship
 - Territoriality: get out of my space
- Two disadvantages of various modes of communication are:
 - Complexity in messages can lead to misunderstanding and the need for an extended learning period (sensitive phase).
 - A message that is easy to locate by the targeted receiver can also give away one's location to eavesdropping predators.
- **Auditory Communication**
 - Encoding Properties
 - Pitch - the frequency of the sound waves
 - Modulation - pure tone/pitch or changing: constant volume or changing
 - Pattern: on/off, continuous, or repeating
 - The transmission distance of an auditory message is a function of sound's pitch (frequency). Low pitches have long wavelengths that travel farther before the waves fade.
 - Sounds that are highly modulated and have an on/off pattern are the easiest to do the arrival time comparison.
 - Birds cooperate by making alarm calls to warn against predators. You warn me this time, and I will warn you next time (**reciprocal altruistic**). For ground predators they are not worried about giving away location so they use extremely modulated in pitch and have a rapid on/off pattern. For aerial predators they don't want to give away location so they use continuous, constant low-pitch tone.
- **Olfactory Communication**
 - Odor molecules used for communication are called **pheromones**. Pheromones are able to persist in the environment after the sender has left the area. Most often carries information about identity and reproductive condition.
- **Visual Communication**
 - Information can be encoded visually through color, pattern, and movement.
 - The receiver of the visual communication must be able to see the sender.
- **Tactile Communication**
 - To be close close enough to touch each other means we are close enough to hurt each other.
 - Information is tactilely encoded via: location touched, appendage used to touch, intensity of touching, and pattern of touching.
- **Gustatory Communication:**
 - A specific molecule binding to a specific receptor encodes the information. Some

male mammals, such as deer and antelope, can judge the reproductive condition of the females by tasting the hormones in the female's' urine.

- **Electrical Communication**
 - Sharks and bony fish send out electrical signals to each other.
- **Territoriality** is the area that an organism will defend against incursion and use by others. An animal has a **home range**-the area the animal visits in a given time period.
 - The functions of territorial behavior are:
 - Spacing of individuals, pairs, and groups to reduce competition predation, and parasitism
 - Stability one territorial boundaries are set then they only have to do minimal maintenance and extra energy can be used to produce offspring
 - Territorial displayed are ritualized-specific signals are used in a specific sequence. The one that does the trial the best wins the territory. This **ritualized aggression** can prevent physical damage to combatants.
 - The territorial behavior needs to peak when the resource is at its maximum benefit. Widely available but low quality = no defense. Scattered (clumped) availability = defense.
 - The timing of behavior can be a function of learning

HISTORY OF LIFE TIMELINE

Self replicating organic molecules (amino acids) → RNA → DNA → Cell Membrane → Cyanobacteria → Eukaryotic Cells (Mitochondria, Chloroplasts) → Soft-bodied animals → **Vertebrates** → Jawless Fish → Fishes with Jaws (Cartilaginous Fish and Bony Fish) → Amphibians → Reptiles → Synapsids and Diapsids

Synapsids → Mammals → Primates → Anthropoid (any monkey or ape) → Hominoid → Hominin

Diapsids → Dinosaurs, Pterosaurs, Crocodilians, Lizards, and Snakes

Plants

Spores → Cones to hold Seeds → Flowering Plants

Insects

Arthropods → Wingless Hexapod → Stiff-Winged Insects → Folding Wings → Metamorphosis

RULES OF DRAWING PHYLOGENIC TREES

A descendant species cannot be older than its ancestor. Backwards evolution is called yo-yo (rare). Take time into consideration.

