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The Human Animal
- Adaptation of an organism: biotic, abiotic
- Look at it in terms of being a process

Darwin's Voyage of the Beagle
- **Charles Darwin**, 1800s toured the world on a boat to observe evolution of species
- Most of what we know about evolution is because of Darwin
- Darwin ventured to England, E.coast of S.America, **Galapagos islands*** (extremely important)
- Journey was started 1831
- 1859: "**On the Origin of Species**", when he was able to compile all of his ideas into a book

Darwin's Finches on Galapagos
- W.coast of S.America
- A lot of the finches there were very similar except for the **shape/size of beak** and what they did with them
- Darwin noted the variation b/w beak size and type, different kinds of morphologies were associated with the different variations of the environments and food sources, this was the basis of Darwins observation that these were the diff variations of ancestors. Organisms become adaptive to their environment over time which is an example of decreasing competition for resources available
- **Ecological niches**
- Through the absence of the different finches, this was how he was able to come to these observations

Evolution Terms & Concepts
- **Heritable traits**: traits passed down through generations (genes) traits (feature),
- '**Fitness**': relates to the **survival** and r**eproductive** abilities of an organism
- Adaptations: elements that increases your ability to have reproductive success
- Evolution acts on **populations** at a time, changing traits through **generations** NOT on single **individuals**
- Ex. The swirls on the shells varies among that snail population which shows that there is always variations among traits in a population
- If their trait has an impact on their survival, then they can lead to variations and differences in their 'fitness'
- The tail of the peacock is an adaptation since it improves the attraction and success rate of reproduction EVEN if it creates more danger, *but if it increases the chance of reproduction and they are able to survive then **it is an adaptation***
- Adaptation doesn't change individuals, it changes the entire pop over time ex. The horse used to be small with toes and over time there was a gradual increase of size and decrease in the number of toes bc it is better for them to be faster when running and helps them to avoid injury
- Traits change over time

DNA: The Genetic Code
- DNA (**deoxyribonucleic acid**) is the source of info for all of the heritable traits
- DNA (our **genetic code**) is common to every single living organism, they share the same blueprints
- The units are different, the differences and similarities of the unit in the DNA allows us to see the change and how we diverged from different species
- We have all descended from **common ancestors** because there are common **genes** between all organisms, indicating our fundamental **relatedness** to each other

Commonality of All Life Forms
- shows how life has evolved from a bacteria like organisms to plants and then animals
- We are all related to a common ancestor

Tree of Life
- **Prokaryote cell**: 'before the seed'
- Archaea: like bacteria but live in very hostile environments ex. Volcanos
- The origin of life but from those we got eukaryotes
- Eukaryotes: 'true cells', have organelles
- Protista: unicellular eukaryotes
- Autotrophs: make their own food (photosynthesis)
- Fungi: absorbs food
- Animalia: ingests food
- Use similarities to group organisms that have similarities into the same groups
- Is an evolutionary tree and you must recognize different traits as the different events in evolutionary time

Building the Trees
- We have a hierarchy which gives us taxonomy (decides how name etc.)
- Within kingdom of Animalia there are approximately 35 phylum which are major groups of animals
- Binomial nomenclature (name things w/ 2 names) always *italicized* or <u>underlined</u>

Evidence For Evolution
- Fundamental source of evidence: fossils
- # of conditions that need to be met in order for fossils to be created
- Bottom of some kind of aquatic environment
- Covered in sediment and if occurs quickly enough will preserve and if happens for long enough> will fossilize
- Hard parts fossilize better as opposed to soft parts ex. Jellyfish
- Sedimentation from volcanic ash

The Fossil Record
- Most fossils of past: most of those organisms don't exist but we see similar animals to the ones found in fossils but a little different; evidence of evolution
- New versions of the fossils, evidence of evolution

Transitional Forms
- From ancestral to modern version expect that there are forms in between, b
- Ex. Birds from dinosaur ancestors
- Fossils also preserve evidence of pigments

Evolution of Whales
- Another ex. Of transitional forms is Whales: mammals are terrestrial in aquatic> terrestrial tetrapod the land animal turned into the whale and there was a gradual shift in its habits which lead it to become a whale and this occurred through the reduction or eradication of limbs and the limbs that stayed were changed to help with propelling in the water

Vestigial Structures
- Loss of feature but there is still a remaining glance of that feature but no longer serves that purpose so vestigial structures are proof that evolution has occurred
- ex. Fish live in complete darkness without their eyes in complete darkness caves, they continue to maintain the internal structures within the fish (ex. Eye sockets in the skull) but they do not have eyes
- So in the past their ancestors lost their eyes as an adaptation, in the past probably because it would cause more harm to have eyes in the dark if they cannot use them
- Ex. Kiwi now a flightless bird in Australia but they still have the bones etc. that show that they were able to fly in the past
- Evolution can sometimes favour loss of structures, limbs etc. a genetic and environmental cost to an organism and in turn they will lose it
- Loss of structures are adaptations and not just the production of new ones
- Ex. Snakes (fossil rail living) snakes are reptiles that have lost their limbs but still have vestiges inside of them of limbs
- Vertebrates: tail: coccyx is a reduction in the number of vertebrae that are posterior to the pelvic gurdle and that shows that we used to have a tail but now serves us no function

Distribution in Space and Time
- Principle behind the process by which we know how old things are
- Geological stratigraphy, the measuring of the layers of the earth and its geological deposits
- Can date organisms relative to one another by the depth of their location in the earth to narrow down the relative aging
- Absolute dating is giving an actual date

Radiometric Dating
- The physics of the element
- Element: nucleus, protons, neutrons, electrons: Balance between protons and neutrons and some decay over time and when this happens they decay and become an isotope and when find rocks made up of elements and means that they have radioactive decay so they can look at the isotopes in order to trace back how long they have been decaying> half-life (the amount of time take to decay element by 50%) parent and daughter isotope, carbon dating etc. how long has this been decaying and then we know when they were formed (know absolute date)

Biogeography
- Also the geographic space across the world
- Biogeography: having organisms in one place of the world and not the other
- The geography of the earth is dynamic and will not look the same in 100 mill years
- Pangea: massive amount of extinction has Pangea formed
- Marsupials that feed their young in pouches in multiple places on earth and this occurred bc they were connected at one point in time which has allowed them today to be found in Australia (ex. Kangaroo) and north, south, and central America (ex. opossum)

Organism Distribution in Time

- 3.5 bill years ago (the estimate of origin at life but keeps getting pushed back)
- Large divisions of time: era
- Short division of time: period
- Precambrian period,
- Cambrian period is the emergence of landforms and most animal forms developed at that time so Cambrian period is essential bc important evolutionary event
- Ordovician: somewhere in this period the organisms in water migrated over onto land
- First animals to follow from water to land to feed on these plants were insects meanwhile in the water they are evolving to produce vertebrates
- Carboniferous period: Land covered in massive amounts of vegetation and are what we now use as coal thats why called carboniferous period
- 250 mill years: Pangea (changed the climate dramatically and made it very dry and hot)
- Prior to Pangea there was lush forests with insects but once Pangea occurred the amphibians had to return back to water but reptiles were a group of dependents of amphibia were pre-adapted to Pangea and were perfectly tailored for it
- Started with chicken-like dinos and later changed to herbivore and then carnivores
- 65 mill: cretaceous (flowering plants)
- start of Mesozoic era and begin of the Palaeozoic era after 65 mill to the senozoic era bc of the asteroid which was the trigger to the changes in the climate globally which a nuclear winter occurred (ice age), earth was shrouded by a cloud of ash which covered the sun completely for 5 months and in turn the dinos were not able to survive
- The ones that could survive and prepared to survive this nuclear winter were small animals (furry tetrapods)
- Age of mammals and then man was able to adapt and versify
- Our story starts at approx 7/8 mill years ago with primates but humans have only been around for about 2 mill years
- Homeothermy: maintain a constant body heat > the birds and how they survived the nuclear winter

Homologies

- *Any kind of trait that is common among organisms bc they have inherited it from a common ancestor*: retraces their genealogy their evolutionary history to their ancestors
- ex. Internal structure of the limbs of terrestrial tetrapods incl. the homologies in our limbs
- Forelimb of human arm, if look down at other organisms they have all of the same bones but just in a different form, the bones are still all there in the same order with a few modifications which is an indication that we have shared a common ancestor at some point
- Homologies can be traced all the way back to the origin of life, cells: animal and plant cells, plant cells have chloroplasts but apart from that animal and plant cells are extremely similar, since they contain all of the same units indicates that they have diverged from a common ancestor in the past
- Tree of life: the similarities that they share link them back to the common ancestor

Homologies in Development

- All have similarities in embryo even though they look so different as an end result
- Ex. Gill slits, the fact that these structures are present in these different stages of embryo development shows that we share a common ancestor

- “ontogeny Recapitulates phylogeny “ Study of embryonic development and evolutionary history: we are all elated to one another
- Homologies can be any kind of trait not just physical, anything reflected of a genetic makeup reflected in the organism

Analogies (Similarities from Convergence)

- analogies: Due to common requirements, converge certain traits to a common theme because of different circumstances that have caused them to adapt to similar structures ex. Shark and whale
- Shark ancestor fish whale from terrestrial beings
- Got look bc they both evolved it as an adaptation to the same situation, analogies cause confusion
- 4 times evolving of power flight: bats, pterodactyls, insects, birds; should not be grouped together bc of their similarity to fly but know that they all have different common ancestor they have their wings bc of the same situation of benefiting them more to be able to fly

Observable Evolution

- Continuously seeing evolution happening on a daily basis
- ex. Development of resistance of bacteria to antibiotics and drugs
- Developing resistance: Bacteria are going to be susceptible to antibiotics

Evolutionary Change
- Beak height was measured to look at the variation
- There was a drought in the year following the measurements
- Had an effect on reducing the kinds of foods that were out there and birds with larger beak ended up eating better, those with smaller beaks did not survive as well
- After the drought went back to measure, there was much less birds present and there was a shift in the average size of beak (larger beaks)

Industrial Melanism
- Over past 200 years there was a massive boom in industrialization > coal
- The coal darkened the environment bc of the soot, so the surfaces of forests became darker so darker moths lived more bc they were camouflaged better than the lighter moth

Artificial Selection
- The ancestor of many modern vegetables was a wild cabbage which was selectively evolved
- ex. Kale is just overdressed leaves from this cabbage
- All of these vegetables are the same species of plant bc they have the same ancestors because prior to human intervention they did not exist
- Modern dogs are variations from the same common ancestor: the wolf

The Evolution of the Human Leg
- There is a template for the trait that has evolved over time, it doesn't just come out of no where it gets built upon over a certain period of time
- Humans in good shape can outrun a horse in a marathon bc the horse will tire themselves out
- This variation has been developed over time from out ancestors
- Cambrian explosion: 1 mill after the first vertebrates evolved (fish)
- The evolution of terrestrial tetrapods evolved from fish that had more supportive body structure because it had fins that were linked up directly to the vertebral column which could support its structure and support itself on land
- Joints in their limbs allowed them to articulate better and to support their body weight
- Fingers and bones evolved protective covering: keratin
- First showed up on toes but originally the keratinous covering would've been claws and you can start to see the evolution of flat toes as opposed to sharp claws (started on big toes)
- The ability to walk upright: ancestors lived up in trees and at some point migrated to the ground and walk upright
- Having bones underneath you is more efficient to walking upright as opposed to out to the side
- The evolution of the movement of toe from the side of the foot to the front because humans no longer needed to be able to grab trees with their feet they needed to be able to walk and run so having toe at top was more efficient
- Legs gradually became more slender and more articulated in ankle to benefit walking and running
- The evolution of the leg is ~440 mill years old, evolution doesn't happen over night and traits develop over time when the requirements of the organism change and they don't occur on blank slate they occurs on trait that was already there

Mechanisms of MicroEvolution
- Anatomical traits change over massive amount of time (macroevolution)
- What causes the changes in gene frequencies over time (microevolution)
- The production of gametes, (gametes: sex cells) there is the potential for there to be mutations when producing gametes and things can go wrong
- Random process which determines which genes are part of next generation (no idea which sperm will become the father) this is genetic drift
- Selection can mean that some don't exist so if they don't survive and reproduce then their genes will not be passed down
- There is the movement of adult individuals from different environments then that means that there will be genetic variation added or taken away so it will change the gene frequency in that pool

Mutation
- DNA is a double helix because it is a ladder wrapping around itself
- In the process in adding new letters in the DNA when reproducing errors can occur called mutations
- Hopefully mutations are neutral but if they do have an effect on a trait than they are likely bad bc our traits are the way they are bc of evolution
- However, new traits emerge and when they are somewhat better they get selected and this is when in natural selection they get amplified in the next generation
- Ex. Beetles with DNA making them green but there are variations in the genes but they are only expressing certain traits bc trait dominants and a certain portion of their offspring will have differences that may or may not be favourable for the individuals

Genetic Drift
- There is a variation in the gametes created, the DNA in the gametes are unique and the different versions of that gene are called alleles
- Gametes are different from one another because they have different alleles

Population Bottlenecks
- Reduced through process not related to genetics, is related to something else
- Natural disasters have an effect on the population and it is often random
- Certain portion of population dies off leaving the remaining portion to procreate and this will change the gene pool drastically
- The frequencies and proportions of the genes present change
- Randomness plays an important role although it is very infrequent

Bottleneck
- Random event that is a cause of the bottleneck in genes that has nothing to do with the genetics of the individuals and how adapted they are to survive

Migration and Founder Effect
- Leave population: to migrate
- Start population: founder
- If a subgroup leaves they are taking a particular group of genes and starting a population with those genes so the new generation will be very different from the original because there is a unique genetic variation bc they have a different gene pool than the original group

Natural Selection
- The process by which some individuals survive and reproduce better than others based on the variation of genetic types and frequencies leads to differences in individuals and their survival and what is passed down to the new generations which leads for them to survive and reproduce better
- When some individuals survive better bc they aren't eaten that means that their genes will be more common in the next generation bc they survived better than individuals with genes for different traits

Sexual Selection
- Occurs when some indie. Have greater reproductive success bc they are better at proving that their traits are better than the others so that they should pass down their genes to the next generations
- This is another layer to reproduction that is unique to natural selection

Evolution Terms and Concepts
- Must be based in genes, when see genetics for particular trait there are different versions to that trait to allow for variations
- Anything that makes an ind. more likely to survive and reproduce over other individuals that is considered an adaptation
- The process of evolution is the change from generation a to generation b not in individuals