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WHY EVOLUTION IS TRUE

Chapter 1: What is Evolution?

- Darwinism is the theory of evolution by natural selection
    - "Life on earth evolved gradually beginning with one primitive species – perhaps a self replicating molecule – that lived more then 3.5 billion years ago; it then branched out over time, throwing off many new and diverse species; and the mechanism for most (but not all) of evolutionary change is natural selection." (p. 3)
    - Consist of six components:

EVOLUTION - *Species has genetic change over time b/c of DNA mutations*

GRADUALISM - *Species today are descendants of species who lived before*
- *Takes many generations for substantial evolutionary change*
- *Each species evolves at a different pace (e.g. bacteria vs. birds)*

SPECIATION - *Ancient species have split into different descendant species*
- *Explains diverse and vast number of species living today*

COMMON ANCESTRY - *Descendants can be found using DNA sequences or fossils to show the relationship between ancient species*

NATURAL SELECTION - *Genes leading to survival/reproduction will have more copies than genes that don't ("bad" genes weeded out)*
- *Only process that can produce adaptation*

NONSELECTIVE MECHANISMS OF EVOLUTIONARY CHANGE
- *Evolution is random (dependant on number of offspring each family within species has)*

- Evolution is a scientific theory (i.e. it must be testable and make verifiable predictions)
- Darwin's predicts what we should find in living/ancient species because of evolution:
    - There are fossil remains of ancient life, so we should find evidence of evolution thru fossils
        - ? *Fossils should be of more complex species as the layers of rock become younger*
        - ? *Should be able to see species change over time showing adaptation*
        - ? Should find cases of speciation in fossil record (one line of decent dividing into new)
    - We should be able to find species that link together major groups with common ancestry
        - ? E.g. birds with reptiles and fish with amphibians
    - Expect that species show genetic variation for many traits and have some imperfect designs

Chapter 2:

Statement-Fossils are evidence of evolution.

We can measure the actual ages of some rocks using radioactivity.

Rocks that bear fossils are sedimentary and can't be dated directly.Opponents of evolution often attack the reliability of these dates.

Hundreds of examples of evolutionary change in fossils-gradual and punctuated.Fossil records give no evidence for creationist.

Transition forms-Fossils or organisms that show the intermediate states between an ancestral form and that of its descendants are referred.

Microevolution-Physical change in same specie over time.

Macroevolution-One very different animal/plant can come from another.

Ground-up theory

Fossil teaches us three concepts.

1. Gradual change witihin lineages,splitting of lineages and existence of transitional forms.
2. Transitional forms occur in fossil record in the right time.
3. Remodeling old into new.

Chapter 3

Evolution explains distribution of species around the world.Darwin states that they had a common ancestor.How come they disperse so widely?

1. Continental drift- it isn't trees that migratated from continent to distant continent it is the concentinents that moved,carrying the trees with them.
2. Molecular taxonomy-

Convergent ecolution-organisms that aren't closely related independently evolve similar traits due to adaptation to similar environment. Convergent evolution demonstrates three parts of evolution: common ancestry,speciation, and natural selection.

Natural selection will give you some traits despite the species.However,you will retain some charcteristic traits of your ancestors.

Species living in one area should be descendants of species that lived in the same place.

With a few exceptions,animals and plants on oceanic islands are most similar to species fround on nearest mainland.

Chapter 4: The Geography of Life

- Endemic species (found nowhere else in the world) in oceanic islands are evidence of evolution
    - Three islands of Juan Fernandez have 5 bird species, 126 plant species, a fur seal and several insect species that are endemic but have no native amphibian, reptile or mammal groups (common in that area of world (pp. 87-88)
- Darwin proposed similar species in different continents were caused by evolution
    - On Darwin's Beagle voyage, he discovered fossil seashells in the Andes (mountains/were one underwater) continents could change over time
        → *Plants/animals that could disperse large distances and evolve into new species after*
        they dispersed, combined with ancient shifts in the earth (e.g. glacial expansion) caused similar species to be in different continents (p. 89)
- B/c of discoveries of continental drift and molecular taxonomy, scientists could identify how different earth's past geography was (continents shifted, joined, and separated)
    - Have accumulated DNA info and protein sequences that tell us evolutionary relationship between species and the time they separated from their ancestors (p. 90)
    - As species diverge from common ancestors, their DNA sequences change in a straight-line fashion over time = "Molecular Clock" (MC)
        → *Used to estimate divergence time of species w/ poor fossil records*
        → *Using MC, can match evolutionary relationships b/w species with movements of*

continents/glaciers, and formation of land bridges like Isthmus of Panama to tel whether the origin of a species matches the origin of a new continent (p. 90)

- Convergent evolution occurs when species that live in similar habitats will experience similar selection pressures from their surroundings
  - Species may evolve to look/behave alike, but retain characteristic traits of ancestors (p. 94)
- Convergent evolution shows the three parts of evolutionary theory working together:
  - COMMON ANCESTRY - Explains why Australian marsupials share common characteristics while placental mammals share diff ones
  - SPECIATION - Common ancestor gives rise to many different descendants
  - NATURAL SELECTION - Makes each species well adapted to its environment
- Continental drift explains why many species show convergent evolution
  - E.g.) Australian marsupials were predicted to have originated in North America (with fossils dating back to 80 million years ago (MYA)
  - Spread outward as they evolved, reaching tip of South America about 40 MYA
  - Made it to Australia about 30 MYA and evolved to the approx. 200 species there today
    - → *Australia and South America had been joined as supercontinent Gondwana, which attached to Antarctica (fossil marsupials found there dating 35-40 MYA) (pp. 94-95)*
- Evolution can also be explained by biogeography and glaciation periods
  - E.g) Conifer trees, *Glossopteris,* were one of the dominant plants of the Permian (glacial period, 290 MYA) whose traits suggested lived in temperate area w/ cold winters (p. 98)
  - *Glossopteris* fossils, however, were only found scattered across the southern continents
    - → *Southern continents were attached to Gondwana during the Permian (fig. 21, p. 98)*
    - → *It wasn't the trees that migrated b/w continents but the continents that moved around, carrying the trees with them*
- There are two types of islands which show evidence of evolution:
  - CONTINENTAL ISLANDS - Were once connected to a continent but separated due to rising sea levels flooding land bridges or by continental drift
  - OCEANIC ISLANDS - Never connected to continent
    - Arose from sea floor as volcanoes/coral reefs
- Evidence of evolution is shown in the different species found on the two types of islands
  - The only native animals on oceanic are plants, birds and insects/arthropods
  - Terrestrial mammals, amphibians, freshwater fish, and reptiles often thrive when introduced by humans to oceanic islands, but only naturally occur on continental islands
    - → *Oceanic islands were never connected to land the only species that would be able to travel across seas from distant lands (e.g. some terrestrial/aquatic mammals, animals who float on rafts such as logs, insects, birds, etc.) (p. 104)*
  - The species moat similar to those inhabiting oceanic islands are usually found on the nearest mainland, even though their habitats are different
- The distribution of life on earth is mainly caused by two things:
  - CHANCE - The dispersal of animals/plants depends on variables such as winds, currents, and opportunities to colonize
  - LAWFULNESS - Many plants/animals arriving in new and unoccupied habitats will evolve to thrive there and form new species
    - Many species go extinct b/c of non-native inhabitants (e.g. humans)

Chapter 5: The Engine of Evolution

- Asian giant hornet (predatory wasp in Japan) is world's largest insect who preys on English honeybee to feed larvae
  - Lone hornet finds nest, marks w/ pheromone, then group hornets decapitate honeybees

- Japanese honeybees adapt to kill hornet before it marks hive (raise temp and cook hornet)
  - *Unless reintroduced or adapt defenses, English honeybees will go extinct in Japan*

- More examples of adaptations include:
  - Parasitic worms infect ant, make abdomen red, eaten by birds, worm eggs in fecal matter
  - Mimicry of plants that look like animals and animals that look like plants
  - Pileated woodpecker has long tongue to eat ants from inside tree (poke hole and use tongue) and extra bone in skull to prevent brain damage from hammering tree

- Natural selection is process that changes genetic composition of pop'n by increasing proportion of genetic variants that enhance survival and reproduction (p. 117)
  - Adaptation to env't is inevitable if species has right kind of genetic variation
  - In order for adaptation by natural selection to occur, population must be/have:
    - *VARIABLE* - *Have to show some difference in trait (polymorphic)*
    - *HERITABLE* - *Some proportion of genes has to come from changes in forms of genes (variation has genetic basis)*
    - *MUTATIONS* - *Accidental changes in sequence of DNA that occur as errors when molecule copied in cell division*

- Evolution by selection is a combination of randomness and lawfulness
  - RANDOM PROCESS - Mutations occur that generate many genetic variants (good and bad)
  - LAWFUL PROCESS - Natural selections orders this variation (keep good and get rid of bad)

- Every adaptive trait must:
  - Begin as a modification of an earlier trait/feature
  - Each step in evolution must have trait that inc fitness in individual (not necessarily group)
  - Adaptation must evolve by increases reproductive output of its possessor
    - *Gene that kills organism after reproduction has no evolutionary disadvantage (explains senescence in old age)*

- Evolution can occur without natural selection by Genetic Drift (random process)
  - Every individual had two copies of each gene (can be same or diff)
  - Every time sexual reproduction occurs, one member of each pair of genes from each parent makes it to offspring (random)
    - *B/c number of offspring is finite, frequencies of genes in offspring aren't present in same freq as parents (proportion of diff alleles change over time by chance)*
    - *Mutations can enter fray and rise or fall in frequency b/c of random sampling*
    - *Can cause genes to become fixed in pop'n (100% frequency) or lost completely*
  - Genetic drift can overpower natural selection (especially in small populations)
    - *Sampling effect can be so large it raises freq of harmful genes even though selection works in other direction (genetic diseases in small, isolated pop'ns)*

- Artificial selection mirrors natural selection (but is much quicker)
  - Difference is that in artificial selection breeder choosing good/bad traits, not fitness

- B/c of large pop'ns and short generation times, bacteria easily becomes antibiotic resistant causing many drugs ineffective against certain strains (TB, HIV, penicillin resistance)
  - Evolution of bacteria creates arms race b/w humans and microorganisms

- Evolution in the wild by natural selection is very slow and can occur on a small or large level
  - MICROEVOLUTION - Small changes in one/few features of species
  - MACROEVOLUTION - Change of one species to another

- STABILIZING SELECTION - Adaptation to get rid of genes higher/lower than optimum
  → *No change in optimum or average trait*

Chapter 6: How Sex Drives Evolution

- Sexual dimorphisms are diffs in traits between sexes of species
  - Many male species have sexual selected traits that inc reproductive fitness but bad for viability
    - *Peacocks have large, colourful feathers that impede flight and attract predators but they attract females (increase reproduction)*

- Adaptive traits for sexual selection must optimize the organism's reproductive fitness while not declining viability too much (cons must not outweigh pros)
  - Sexual selection comes in various forms
    - *MALE COMPEITOIN - Traits adapted for male to physically compete with other males for female*
    - *MATE CHOICE - Traits adapted for male to look more appealing*
    - *POST-MATING COMPETITION. - Trait adapted so that male prevents other males from inseminating same female (steal paternity)*

- The two-fold cost of sex is described as the tendency for asexual reproduction to occur more often and get rid of sexual reproduction in species who can do both
  - If normal form is sexual and mutant form is parthenogenesis (production of eggs that develop w/out fertilization), proportion of women would quickly rise above 50%
    - *All females produced asexually by mother (no more males no more sexual reprod)*
  - Since sexual selection is still prevalent in most species, it must have evolutionary advantage

- Evolutionary difference between males and females is matter of differential investment
  - More investment in eggs and pregnancy (retain/nourish fertilized eggs) than sperm
    - *Males have little to lose when mate with substandard female (sick/weak) but females must be picky (b/c limited number of eggs) males compete for females*

- Sexual dimorphisms in socially monogamous species (males/females pair up to rear young) are b/c species are socially monogamous but not sexually monogamous
  - In species where females more promiscuous, females have traits for mate choice and males invest more in child-rearing than females (rare)

- When picky females choose mate, look for males that can help produce more, healthy offspring (direct benefit) or male that has better genes than others (indirect benefit)
  - Male gives best genes to progeny and female give genes for preferring those good genes
    - *Females attracted to male's bright colours, ornaments b/c it represents direct/ indirect benefits*
  - Sensory bias model says sexual dimorphism driven by preexisting bias in fem nervous system
    - *Bias product of natural selection not finding mates (E.g. if attracted to red b/c eat berries, more likely to be stimulated by red mate b/c of preexisting preference)*