Evolution

- Variation in Populations
  - Peppered Moth
    - Baron Isaacson
      - Two forms
        - Light
        - Dark
      - Anomaly: more predominant in population
      - Rare
      - Lepidoptera
      - Coal-powered factories increased soot
      - 40% months were carbonate
      - Reacted in typical becoming dominant vs<lant again
      - 1956 clean air legislation passed
      - 1980's gave rise to industrial revolution
      - Mutation due to mutation in a gene
      - Dark phenotype gave survival advantage over white phenotype
      - Genetic mutation introduced new alleles into population
  - Gene Pools
    - Total collection of alleles in a population
    - Fixed genes
      - Only have one possible allele
      - Don't contribute to any variation in population
      - 100% genes are fixed
      - Don't contribute to evolution
      - Affected by movement of individuals as well as environmental change
      - Genes transmit phenotypes from one generation to next
      - Allele
        - Gene serial in different forms
      - Variants in allele leads to variation in population
    - Isolating & Restricting
      - Allow only alleles present within population to mix
      - Form groups with similar alleles + new new species
      - Geographical Barriers
    - Bacterial dragon
      - Energy of variation available in a population constricted by alleles available in gene pool
      - Good survey genes for
        - Wings
        - Hard shelled eggs
        - Response to some chemicals
        - Response to digest cellulose
      - Bad
        - Rudimentary traits
        - Useless
        - Poorly
      - Bad survey genes for
        - Tail
        - Rudimentary traits
        - Useless
        - Poorly
  - Allele Frequencies
    - Genetic polymorphisms
      - Varying phenotypes due to genetic differences
    - Affected by
      - Mutations
      - Migration
        - Immigration
        - Emigration
      - Reproduction rate
        - No. offspring born to individual pop
      - Genetic drift
      - Biotic rate effect
      - Founder effect
    - Evolutionary theory
      - Favourable traits become more common in each successive generation
      - Survival of fittest
      - Members that survive to pass on genes carry traits most suited to environment/circumstances
      - Measured in %
  - Population size
    - Large populations
      - Individuals make only small contribution to gene pool
      - Fluctuation occurs slowly
      - Most changes are adaptive
      - Natural selection is strong force
    - Small populations
      - Individuals make large contribution to gene pool
      - Evolution can occur rapidly
      - Many changes non-adaptive
      - Many changes due to chance events
  - Mutations
    - Give rise to new alleles
    - Rarely necessary
    - Mostly recessive + masked by original gene
    - Ultimate source of variation
  - Migration/Gene flow
    - Populations are rarely completely isolated
    - Gene flow occurs between different populations
    - Gene flow
      - Transfer of alleles from one population to another
        - Immigrants add alleles
        - Emigrants remove
      - Movement of individuals between populations
      - Moves alleles carried by individuals
      - Can change allele frequency in both populations
  - Random Genetic Drift
    - Random changes in small populations
    - Changes in allele frequencies due to
      - Allele segregation
      - Random assortment
      - Fertilisation
    - Certain alleles are passed on whilst other aren't & lost within that population
    - Caused by sudden drop in population
    - Bottleneck Effect
      - Other due to catastrophic event or period of genetic constriction
      - New population only carries alleles new present
      - Original gene pool cannot be recovered & alleles are lost
      - Experienced drastic bottleneck
      - Declining population meant parents mated with offspring
      - Resulting generations had very similar alleles
      - Caused increase in frequency of mutated alleles causing negative effects on fertility
      - Other effects include low resistance to disease & more affected by infections
      - Only ~10,000 cheetahs left in world
    - Cheetahs
    - Founder Effect
      - Gene flow
      - Occurs when small number of a population migrates & settles in new area
      - Founding population carries only small fraction of original population genetic diversity
      - May differ both genetically & in appearance compared with parent population
      - Unfortunate alleles may have greater chance of coming together than in original population
      - Amalgamation of 1000 British settlers + Pilgrims/pacts in North America
      - Formed community
      - Amish
        - Hawthorn
        - Polydactyly
        - Ends in tears
        - Arrival 1 persons had recessive allele for Ellis-Van Creveld Syndrome
- Natural Selection
  - In breeding/Consanguinity
  - Charles Darwin & Alfred Wallace
  - Gives some advantage/disadvantage
  - Favourable traits selected for & inherited
  - Traits become more common in subsequent generations
  - Traits on two proportions
    - Individuals differ from one another + show variation
    - Many variations caused by mutations in alleles & are inheritable
    - Many offspring produced but only a few survive to reproduce
      - Struggle for existence & only some organisms can reproduce
      - Makes them better able to reproduce & pass on alleles to following generations
    - Some organisms have had more suited to environment than others
  - Fitness
    - Capacity of an individual to survive & reproduce in a given environment
    - Only selective mechanism leading to adaptive evolution
    - Acts on individuals to produce changes in a population over time
    - Advantageous characteristics become common & disadvantageous ones disappear
    - Produces organisms/populations that are best adapted to their environment
  - Steps
    - 1. Variation in population
      - An ambition
    - 2. Selection pressures
      - 3. Individuals with antibiotic resistant genes will survive; some others may survive as their ancestors may be less or not at all
      - 4. Resistant bacteria make most of surviving population; only live the subsequent generations have greater proportions with resistance
    - Provides plausible explanation for evolution
    - Natural selection determines which mutations remain in a gene pool, and which ones are eliminated
  - Artificial Selection
    - Breeding of organisms with desirable traits ensures these traits are passed on to next generation
    - Humans influence the evolution of other species
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    - Relies on human intervention to determine which traits are selected for
    - Selectively accepting
    - Factors that result in a struggle for survival
    - Selection pressures
      - Interspecific competition for
        - Food
        - Territory
        - Cause some traits to become more common than others
      - Predator prey relationships
      - Intraspecific competition for
        - Water
        - Nesting sites
        - Favours individuals with certain characteristics/behaviours
          - Kind of parasites
            - Mating behaviour
          - Sexual selection
            - Antlers
            - Peacock feathers
            - Loud elaborate mating calls
            - Fashions often quite costly to animal
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  - Sexual Dimorphism
    - Males & females of a species have different physical features that distinguish them from each other
  - Can be
    - Stabilising Selection
      - Environment doesn't change & doesn't cause disparities from optimal phenotypes
      - Keeps deleterious alleles in check
      - Most common of NS
      - Favours most common phenotype
      - Birth weight in babies
        - Too big
        - Too small
        - complications during delivery
        - Underdeveloped
      - Changes in traits over time
      - Due to changing environment
      - Leads to organisms with characteristics traits favoured
    - Directional Selection
    - Disruptive Selection
      - Favours extremes
- Speciation
  - Describes evolutionary processes that lead to formation of new species
  - Microevolutionary process & can occur in several ways
  - Population accumulates enough changes to establish new species
  - Reproductive
    - Rapid success of speciation events leads to many new species & even generalisation to be formed
  - Species defined in different ways
    - Group of organisms that are able to breed together to produce fertile offspring, under natural conditions
      - Biological species concept
    - Based on similarities in appearance, physiological, behavior or genetic
      - Morphological species concept
  - Variation
    - 1
    - Crisis for some characteristics in a population
    - Differing alleles in gene pool account for variation
    - Good to be in gene flow
      - Mutations cause variation
    - Breeding population isolated from parent population
    - Gene flow ceases
      - Gene occur within parent population
      - Migration
        - variation from parent population
        - Interbreeding (gene flow) disrupted
  - Isolation
    - 2
    - Geographical
    - Reproductive
    - Behavioural
    - Morphological barriers
      - Size
      - Shape
      - Location of gametes
      - Mating different seasons
      - Seasonal
      - Diurnal
      - Lunar
      - Temporal & Climate
      - Contact
      - Prezygotic (before fertilisation)
        - Isolating mechanisms
        - Pre-reproductive
        - Post-reproductive
      - Doesn't prevent mating but prevent offspring being produced
        - Gametes + Zoot&gy = infertile mule
        - Gamete mortality
        - Zygote mortality
  - Selection
    - 3
    - Natural selection
    - Selection pressures
    - Sub population adapts to new environment
    - Many offspring better adaptent to survive affecting population with each successive generation
      - Gene frequencies for these characteristics increases
  - Adaptation
    - 4
    - Mutation
    - Characteristics changed by
      - Random genetic drift
      - Environmental & selection pressures
  - Speciation
    - 5
    - Population has many different features from original ancestor
    - Gene flow has ceased
    - Can no longer interbreed/produce fertile offspring
    - Reproductively isolated from one a new species
    - Allopatric
      - Geographically
    - Sympatric
      - Ecological
- Extinction & Conservation
  - Fossil record shows nearly all species that ever live now extinct
  - Generally occurs quite regularly
  - There've been 5 mass extinctions in last 500 mya that are known of
    - Cretaceous are 65 mya
      - End of dinosaurs
      - Great Dinking
    - End of permian are 250 mya
      - Massive volcanic activity same; since to aspirg 1% last campaigning
  - Mr&ass Extinction
    - Now
    - Currently experiencing high rate of species loss
    - Cause
      - Habitat destruction
      - Agriculture
      - Land development
      - Mining
      - Pollution
      - Pollution of many megaliterse colonisted with change in this regimes
    - Abnormal climate patterns
    - Pressuring Extinction
      - By preserving genetic diversity
      - Natural genetic diversity means
        - Natural selection
        - More susceptible to diseases & selective pressures
        - Loss chance a characteristic that will contribute to survival will alter
      - Large organisms & smaller populations more more at risk
      - Larger population cross sections due to large & diverse gene pool
  - Conservation
    - Habitat requirements
    - Biogeography
    - Threat to other species
    - Reaction to problems
    - Organisms likely to pay co-endangered species
    - Population dynamics
    - Abnormal behaviour
    - Planning to maintain viable gene pools needs to consider
    - Areas where endangered species are protected from human influence & predation
  - Conservation Reserves
    - Difficult to set up
      - Ideal largescaled should area be
      - Single large reserve or several small reserves
      - Population size of species is needed for long term survival
      - Segregation that links one habitat reserve to another
      - Small reserves & wildlife corridors
        - Allow organisms to move
          - Allow seasonal migration
          - Allow interbreeding
        - When resources become scarce
        - Encourage gene flow
        - Are all conservationists these are enough
      - Using islands as safe havens
      - Building predator fences to protect animals from predators
      - Birds released into wild & overbreeding prevention
        - Flapping animals
        - Building new nesting sites to encourage breeding
- Evidence
  - Comparative Studies
    - Comparing organisms + similarities/differences
    - Biochemistry
      - DNA
        - All living organisms use same genetic code
        - Similarity indicates evolution from common ancestor
        - Sequencing shows great similarities
        - Sequences of bases are similar in closely related species
        - Sequences bas similar in more
          - Measure % differences
          - DNA hybridisation
            - Heating
            - Denaturing with strands from another organism to determine amount of conjugated DNA
            - Smaller difference = closer relationship
            - Involves
      - Ribosomal DNA
        - Ribosomes extra/cross = 0% human genome
        - Viruses insert RNA to DNA of host
        - Remains part of host's DNA
        - Passed down only if from cells affected
        - 0.05% mutations in species match + closer relationship
      - mtDNA
        - Circular not sheet
        - Easy to extract
        - Shorter than nuclear DNA
        - Mole mitochondrion destroyed after fertilisation
        - Only passed from mother
          - Allows tracking through maternal line
          - Closer relation + more similar mtDNA sequences
      - Protein sequences
        - All proteins made from 20 kinds of amino acids
        - Type & sequence of a/s compared between species to determine closeness of relationship
        - Sequence bas similar + more diversity related
        - Ubiquitous proteins
          - Present in all living things
      - Genome
      - Junk DNA
    - Anatomy
      - Homologous structures
        - Structures with similar architecture
        - Similar structures + different functions
        - More common embryos are similar
        - Many bone features; not present as adult
      - Embryology
        - Common developmental pathway depends on closeness of relationship
          - Gills
          - Tail
        - Reveals similarities between different species of different lines
        - Provide evidence of common ancestry
      - Vestigial organs
        - Evolutionary leftovers
        - Structures that no longer serves a purpose
        - Are reduced in size in no/serve energy
        - Provide evidence of change over time
        - Common in vertebrate species
        - Humans have up to 93
        - Evolutionary mechanisms can be used to explain existence of these structures
        - Over time organs that were once used because; no longer essential for survival & reduced to non-functional remnants due to conserving energy
        - Eventually may disappear
      - Geographical distribution
        - Study of distribution of organisms & ecosystems around world & over time
          - Northern Australia shares similar flora & fauna with India
          - Eastern Australia shares similar flora & fauna with Malaysia, Coastal South America, PNG, New Caledonia, NZ
        - Supports evidence for existence of Gondwana
    - Biochemistry
    - Embryology
    - Fossils
      - Provide info about age of fossil as well as an indication about past climate & environmental conditions
      - Fossils bottleneck where lower age is not determined
      - Can fossil said to be older/younger than another
      - Compared to fossils near by
      - Relies on understanding that sedimentary rock is formed
      - Relative/Comparative dating methods
        - Sedimentary rock
          - Formed when sediments become deposited over millions of years and pressure is applied
          - Forms in horizontal layers
          - Depositions form defined layers
          - Palaeontologists: set assign relative ages
          - Fossils: that contain cemented short/transitional layers
        - Stratigraphy
          - Matching of layers
          - Uppermost oldest layers on bottom, newest on top
          - Involves techniques where layers in one area are matched to layers some/these also
          - Fossils: layers containing same type of fossils are deposited at same time
        - Fluorine analysis
          - Stone accumulates fluorine when in soil
          - Older fossil = greater fluorine content
          - Amount of fluorine absorbed depends on soil type
          - Fossils buried for same length of time in same area = same fluorine content
          - Bones & antlers absorb fluorine more readily than teeth
        - Using index fossil
          - Good as references to a particular age
          - Must be fossils which were extend during a relatively short known time
          - Must be extinct organisms which had wide geographical ranges
          - Must possess distinctive morphology
      - Absolute/Chronometric dating methods
        - Where appropriate age is determined & assigned to fossil/rock
        - Based on physical/chemical properties of materials in rock
        - Radiometric
          - Based on decay rate of certain isotopes
            - All element containing same no. of protons but different no. neutrons
          - Radioactive isotopes emit alpha/beta/gamma rays at measurable rate
          - Half life
            - Time taken for half radioactive atoms to decay
          - Decay
            - Must down to stable atom
          - Carbon 14 Dating
            - Average % Nitrogen 14
            - Measures beta particles
            - Beta radiation measured & ratio of Carbon 14 to Carbon 12 determined
            - Useful for dating around up to 11,000 yrs
            - Recent improvements in technique permits older & more precise determinations
            - Can only be used on organic materials from fossils
            - Must be calculated with margin of error
              - Older = greater margin of error
            - Limitations
              - Becomes amount of C14 & C12 in atmosphere (was always been same)
              - Assumes rate of formation for C14 is constant
              - Must have organic matter
              - Samples cannot be completely fossilised
        - Electron spin resonance
          - Relatively new
          - Measures properties of electrons in crystals of minerals
          - Gamma emissions induced electrons to expand radius of positionals orbs
          - Electrons come from radioactive sources in ground or from cosmic rays
          - Electrons become fixed & entirely magnetic
          - Can give absolute spin resonance reading
            - Oscillator increases with time
            - Can be divided by background data rate to determine age of remains
        - Thermoluminescence
          - Measure characteristics of minerals in sedimentary rock
          - Thermoluminescence
          - Optically stimulated luminescence
        - Potassium/Argon
          - Measures no. grength range of rocks
          - Done by using sample fractions
          - Useful to ~1000 yrs
          - Growth rings in a sample tree are correlated with dross found in trees of known ages
          - Has been used to correlate & confirm C14 dating
          - Tree rings vary according to climate
          - Tropical regions produce too obvious rings due to little seasonal variation
          - Accurate
          - Only tree ... conditions have to be just right
    - Preserved remains/traces of organisms
      - Tools
      - Bones
      - Shells
      - Impressions on rock
      - Footprints
      - Burrows
      - Preserved waste products
    - Fossils
      - Sedimentary rock
        - Lateral/Cross/Ripples say tools
        - Caves
        - Impressions
        - Burrows + tracks
      - Volcanic ash/rock
        - Fine metamorphic rock + low much heat & pressure
    - Fossilisation
      - Turns organic material into inorganic material
      - Organic matter becomes covered in sediment in an area that lacks oxygen
        - Microbes petrified through
          - Mineralisation
            - Minerals from sediments replace natural biomaterial material, making remains harder
            - Can occur when organisms are covered in sediments
            - Sediments protect organic material from scavengers & elements
            - Generally only feasible hard parts
            - Organism engulfed in sediment
            - Decay minimise organism leaving void in sediment
            - Often results soft tissue of organism
            - Most fossils can be formed if mold is later filled with
              - Minerals salt
              - Minerals in sedimentary rock
          - Cases & molds
      - Can also occur through freezing & dehydration
    - Provide evidence for evolution - revealing common ancestors/transitional forms
      - Suggest change over time
      - Suggest sequence of development leas to more complex
      - Organisms in past not same as those today
    - Fossil record
      - Gaps in Fossil record
        - Evolution
          - Evolution occurs as slow, steady; divergence at exact pace
          - Evolution appears as sudden burst because of lack of fossil evidence to support transition
        - Punctuated equilibrium
          - Species remain same for long periods but suddenly & swiftly change to new species
          - May be in response to sudden change in environment
      - Limitations
        - Most of evidence for evolution comes from fossil record
        - Majority of fossils lost due to weathering & erosion
        - Only small % of organisms become fossilised
        - Fossil record biased toward organisms that fossilise more easily
        - Rare conditions
          - Anaerobic
          - Rapid burial
          - Hard parts
          - Very low organisms fossilised
            - Gases conducive
              - No oxygen
              - Burial capacity
            - Organic matter decomposition
              - Heat
              - Pressure
              - Acidic pH
              - Alkali conditions
              - Condensation
        - Many not yet found
    - Theory
      - Evolution
        - Process by which different kinds of living organisms are believed to have developed from earlier forms during history of earth
        - Gradual development of something
        - Change in inheritable traits of biological population over successive generations
        - Process of gradual change in gene pool of a population of organisms that results a new species
      - Chemical evolution
        - Formation of complex organic molecules from simpler inorganic molecules through abiotic reactions to develop life on Earth
        - Major evolutionary change involving whole taxonomic groups over long period of time
        - Large scale changes
      - Macroevolution
        - Stages
          - Different organisms develop from a common ancestor
          - Organisms develop variations; traits characteristics to the point where they develop into different species / specimens
          - Real forms radiate from stock (adaptive variations) responding to environmental & selective pressures
        - Types
          - Convergent
            - Different types of organisms independently develop to become similarly structured
            - Due to availability of similar niches in environment
            - Occurring as a result from sole selection forces; more similar ones if they develop in different countries
            - Analogous structures
              - Structures that look & function same but have no common evolutionary history
          - Parallel
            - Coordination
              - Many related structures/types of organisms evolve in parallel
              - Gene flow ceases
              - Organisms tend to look similar despite living in different parts of the planet
        - Microevolution
          - Evolutionary change within a species in a small group of organisms over short period
          - Relatively small scale
        - Microbial evolution
          - Development of microorganisms from simple organic & inorganic molecules
      - Evolutionary trees
        - Degree of relationship
        - Distance between species + lines passed above branching ancestor