WHAT IS BIOLOGICAL ANTHROPOLOGY?

What Is Anthropology?

- The study of humanity from the past and present (anthropos = people, + logos)
- Evolutionary origins and how the traits which arise from those origins interact with each other from the past and present (i.e. different people)
- Tapestry of difference which makes the human family
    - It fundamentally studies the role of **CULTURE** on human behaviour
    - It uses a holistic perspective (views humanity as an integrated whole)
    - Other primates are used as a comparative perspective

Subdisciplines of Anthropology

- Cultural
    - Ethnography (written observation of people and their cultures)
    - Ethnology (understanding different cultural behaviours)
    - Socio-Cultural Anthropology (sub-culture of our own culture group of which we may not be a part of)
- Linguistic
    - Origins of language and speech, and the relationships between culture and language
- Archaeology
    - Peoples of the past, their artifacts
    - Ecofacts / biofacts (features of the Earth modified by human activity)
    - Artwork / architecture
- Biological Anthropology
    - The study of human biology within evolutionary framework
    - Human skeletal analysis (interpretation of skeletons)
    - Primatological comparisons and other subfields

Paleoanthropology

- The study of human evolution from the fossil records

Skeletal Biology And Human Osteology

- The study of human skeletal material
- Anthropometry: measuring human body parts

Bioarchaeology And Paleopathology

- Excavating ancient skeletons
- The study of disease and injury in excavated skeletons

Forensic Anthropology

- The study of human remains in a medicolegal context
    - Recent material is considered 50 years
    - Anything older is not considered forensic, but archaeological

Primatology

- The study of biology and behaviour of non-human primates

Human Biology

- The study of human growth, development, adaptation to environments, human genetics

Applied Anthropology

- Uses anthropological data to address present human concerns
    - Medical anthropology is how health and disease affect human populations
    - Cultural Resource Management looks at how previous generations maintained balance with their environment, and applying that today to mitigate the effects of modern development on the land

<u>Cultural Relativism -</u> Cultures are shaped and formed relative to their history and environment

HUMAN EVOLUTION = Biology + Culture = Genetics + Behaviour = Adaptations = Biocultural perspective

<u>ORIGINS OF EVOLUTIONARY THOUGHT</u>

Philosophy And Scientific Thought

- Modern science started with Aristotle (c. 384-322 BC)
    - Made observations of creatures, and noticed that they could be graded in a hierarchical scale, from abiotic - biotic
    - Called this hierarchical scale “scala naturae”
    - Medieval Church took the scala naturae, and added metaphysical beings (i.e. demons, angles, God)

- There was a different conception in Ancient Chinese Philosophy
    - Zhuang Zhou (c. 369-286 BC)
    - Humans, nature, heavens exist in a state of constant transformation, known as Tao
- Islamic Golden Age Philosophy (8th-13th centuries)
    - Transmutation from non-living to living (i.e. mineral to plant, plant to animal, animal to human)
    - Ibn Jhaldun (1332-1406), wrote the Muqaddimah (1377)
        - Developed the idea that humans developed from the world of monkeys
- Greek philosophers were the ones who were re-discovered, however
- Archbishop James Ussher (1581-1656)
    - Wanted to know how old the Earth was, and used the Bible (only accepted text), worked backwards through the old testaments to pinpoint the birth of the Earth to be October, 23rd 4004 BC

The Scientific Revolution

- Chistopher Columbus through circumnavigation discovered the Earth was indeed round
- Ferdinand Magellan found a new species, the Magellan penguin
- Juan Sebasitian Elcano was the first person to fully circumnavigate the world
- Sense of discovery and exploration was the catalyst
- Ptolemy of Alexandria (AD 127-145) had an idea that Earth was the centre of the Universe
    - Wrote <u>The Great Book</u> (AD 150), with this geocentric view of the universe
    - These were adopted by the Catholics as well
- Nicolaus Copernicus (1473-1543) was “first” scientist to propose heliocentrism
    - <u>The Commentariolus</u> (little commentary, 1514) was his work, but he hesitated for publish for fear of death
    - His ideas were removed from circulation pending correction March 1616, and became public again in 1758
- Galileo Galilei (1564-1642)

    - Continued to promote heliocentrism, and was investigated for this
    - Dialogue Concerning The Two Chief World Systems (1632) (argument for geocentrism was represented by "the simpleton", and tortured because of it)
- Andreas Vesalius (1514-1564) was the founder of modern human anatomy
    - Found mistakes of how other anonmists recorded what they observed
    - On The Fabric Of The Human Body (1543) became a classic because of this

The Naturalists

- John Ray (1627-1705) was the first to suggest the reproductively isolated concept of species, meaning that two organisms mating produce viable offspring
    - Definition being new species can arise if separated from other groups of the same species
    - Differentiated organism by whether they produced fertile offspring
    - Basically if they can make babies, they are the same species
        - Differentiated via genera (genus)
- Carolus Linnaeus (1707-1778) standardized Ray's taxonomy into binomial nomenclature (what we use today)
    - Published his ideas in System Of Nature (1735)
    - Coined *Homo* for genus, and *sapiens* for species (italicize in writing, underline in writing)
    - Expands from just genus and species, going further to order and class
- Georges-Louis Leclerc, Comte de Buffon (1707-1788) observed the relationship between the environment and living things
    - Published in Natural History (1749-1788, 36 volume work)
- Erasmus Darwin (1731-1802, Charles' grandfather, an abolitionist)
    - Suggested that all warm-blooded animals arose from a common ancestor
    - Published as a poem *The Temple of Nature* (1803) in Zoonomia
- Jean-Baptiste Pierre Antoine de Monet, Chavalier de Lamarck (1744-1829)
    - Suggested dynamic relationship between organism and their environment ("use-disuse" theory, use it or lose it)

        - Think elongating giraffe neck (Lamarckian evolution/Lamarckism)
- Baron Georges Cuvier (1769-1832)
    - Father of Paleontology
    - Added "Phylum" to Linnaean taxonomy
    - Was a creationist suggested that fossils of animals died of due to the great catastrophic events, and that new animals were created by god in their place
    - This idea is called Catastrophism
    - So now taxonomy looks like Phylum: Class: etc
- James Hutton (1727-1797)
    - Father of modern geology
    - Geologic forces of erosion and deposition were the same in the past as they are in the present
    - Uniformitarianism suggests that these rates never change over time

DARWIN'S INFLUENCERS

Sir Charles Lyell (1797-1975)

- Supporter of Hutton's Uniformitarianism (slow gradual change shapes the universe)
    - Principles of Geology, 3 vols. (1880-1833) expanded on this idea of geologic time
    - Friend of Darwin
    - Due to his work, perception of the age of the Earth increased to encompass a much larger age
    - Interested in latitudinal climate changes, and land's position relative to the sea and its effect on the climate of the area

Rev. Thomas R. Malthus (1766-1834)

- An Essay On The Principles Of Population (1798)
    - The food availability dictates population size (but not vice-versa)
    - Populations tend to increase over generations and outstrip static resources

        - The most marginalized people are the ones who take the blunt of the result of the lack of availability to resources
    - Malthus and principles of population
        - 1.) In each generation more offspring born than survive to adulthood
        - 2.) Competition for resources as a result
        - 3.) Biological diversity (variation) among individuals (the ones that succeed pass those traits on to the next generation)

Darwin VS Wallace

- Charles Darwin (1809-1882)
    - Came from an affluent family
    - Didn't do well with medicine, learnt of lemarc theory of evolution (wasn't a very good scholar)
    - HMS Beagle (1831-1836), accompany a voyage to map the coastline of South America
        - Wasn't first or second choice, but they turned the offer down
        - Captain gave Darwin Lyell's principle of geology 3 volume series
        - Also meant to investigate geology + collect natural history specimens
        - Also traveled to Africa and Australia
        - Brazil imported ~4.9 million african slaves (mostly mining) between 1501-1866 (more than any other country), abolished in 1888
        - Darwin's grandfather was an abolitionist, England was in the process and completed aboloshiment of slave trade while Darwin was on the Beagle
    - Galapagos Islands, off the coast of Ecuador (went around), animals exist where they don't anywhere else (marine iguanas, galapagos tortoise, etc)
        - Archipelago of volcanic islands
        - Made geologic discoveries (with the volcano specifically)

        - Made natural discoveries, documented variations of turtle shells, noticed that each island has a different finch, collected 13 different species of finch

Darwin's Finches

- Birds with slender beaks were eating insects
- Wider and heavier beaks would eat seeds
- Darwin picked up on finch beak shape and what they would be eating

Darwin's Tree 1837 (page from his journal)

- Transmutation: change of one species to another
- Biogeography: Distribution of species through space and time
- Adaptive Radiation: Many species emerging from one/a few ancient one(s)
- Natural Selection: Process of biological change in a species in which adaptive radiation occurs
- Artificial Selection: Selection done by a breeder of some kind

- After reading Malthus, Darwin concluded that competition and a constant struggle for existence is what put selective pressures onto a population of organisms

- Alfred Russel Wallace (1823-1913)
    - Father was a gentleman, but had a string of bad investments, and so lost land and inheritance
    - Attended grammar school, until parents couldn't afford it anymore, and withdrew at 14
    - Moved with his brother in London, and snuck into lectures at the University (London Mechanic Institute), and essentially audited the class
    - Became a surveyor apprentice, and surveyed West England and Wales
    - Started a hobby of collecting insects everywhere he went
    - Read both Malthus and Lyell, as well as Darwin's account of Brazil via Beagle
    - Went to Brazil on the Mischief (1848), to verify the transmutation of species that Darwin proposed

    - Spent 1848-1852 in Brazil, charted Rio Negro in the Amazon basin, made notes on the people he met, their languages, specimens, etc
    - Return to London, cargo ship caught fire, and lost everything and all the specimens except some sketches and notes
    - Thus, he made a second trip to South East Asia (1854-1862)
    - Noticed the strait between Indonesia and whatever, had a separation of animal species, which is now called the Wallace Line
    - On The Law Which Has Regulated The Introduction Of Species (1855), which essentially says that the environment puts influences onto a species
    - Lyell then encouraged Darwin to publish his own theories (was hesitant to publish his work due to the backlash of the scientific community whose ideas were rooted in catastrophism)
    - On The Tendency Of Varieties To Depart Indefinitely From The Original Type (1858), which describes the evolutionary process of competition and how transmutation of species can happen
    - Darwin finally published On The Origin Of Species By Means Of Natural Selection (1859), because Wallace lent credence to Darwin's theory, and also didn't want him to scoop all the credit

Differences Between Darwin And Wallace's Ideas

- Darwin
    - Competition (limited food resources) between individuals of same species to survive and reproduce
- Wallace
    - Environmental pressures on species forcing them to become adapted to local environment

What Is Natural Selection

- A process where individuals with favourable variations survive and reproduce

8 Key Elements Of Natural Selection

1.) All species can produce offspring at a faster rate than food supplies can increase
2.) Biological variation can exist within all species

3.) In each generation, more individuals are produced than can survive = competition
4.) Individuals with favourable traits have an advantage (fitness)
5.) Environment determines if a trait is beneficial = selective pressure
6.) Traits are inherited and passed on to next generation = reproductive success/fitness
7.) Favourable variation accumulate over a long time; later generations may become distinct from ancestral ones
8.) Trait variation and geographic isolation can lead to a new species = speciation

Limitations Of 19th Century Evolutionary Theory

- Exact mechanisms of evolutionary change was unknown (we know now that it is genetics)
- Sources of species variation + how parents pass on traits (miosis) to offspring is unknown (we know now that it is mutations and miosis)

STUDY QUESTIONS

- What are the major scientific developments that led Darwin and Wallace to their theories of evolutionary process?
- How does natural selection lead to evolutionary change?
- What are some of the limitations and gaps in Darwin and Wallace's concept of natural selection?

GENETICS: CELLS & MOLECULES

The Basic Structure Of Life

- Prokaryotic cells are single-celled organisms
    - No major compartments, materials are just floating around
    - Bacteria, etc
- Eukaryotic cells are multi-celled organisms
    - Have cellular anatomy

Eukaryotic Cell

- Organelles
    - Nucleus

        - Includes DNA and RNA, separated from the rest via nuclear membrane, which is semi-permeable, allowing RNA to exit the nucleus
    - Mitochondria
        - Energy production centre of the cell
        - Contains mitochondrial DNA, which codes for energy production, which supports cell production
    - Ribosomes
        - Attached to rough endoplasmic reticulum
        - Reads RNA as it exits the nucleus
    - Cytoplasm
        - Contains free floating nucleic acid, DNA, RNA,
        - Other organelles suspended in cytoplasm to help maintain cell function
    - Cell Membrane
        - Contains all
        - Semi-permeable to get messages in and out of the cell

Types Of Eukaryotic Cells

1.) Somatic Cells
- Make up body tissue
    - Bone cell, muscle cells, red blood cells, nerve cells from brain

2.) Reproductive cells (oocytes and spermatocytes)
- Produces gametes (ova and sperm)
- Sperm + ova = zygote, one cell which contains 23 chromosomes in humans, creating potential for creating human life
- Zygote transmits genetic information from parents to offspring

Cell Division

Mitosis - Division of somatic cells (new muscle cells, blood cells, etc), also only form used for prokaryotic cells

Meiosis - Division of reproductive cells

Chromosomes

- 2-3 m of DNA in nucleus
- Organizes via chromatin
- Duplicates as chromatin
- Organizes into chromosomes (double stranded chromatin)
- Human Karyotype - visual appearance of all chromosomes in a human cell

2 Types Of Chromosomes

- Autosomes (chromosomes 1-22)
- Sex Chromosomes (chromsome 23, determines sex)
- Humans have 22 pairs of autosomes + 1 pair of sex chromosomes
- Chimpanzees + gorillas = 24 pairs of chromosomes (23 pairs of autosomes + 2 sex chromosomes)
    - This doesn't mean they have more DNA, but rather that their genetic material is organized in a different way

Mitosis

1.) DNA replication occurs as chromatin
2.) Nuclear membrane disappears, chromatin combine to form chromosomes
3.) Chromosomes line up at the centre of the cell, microtubules occur at both sides of the cell, attaching to the centromeres of the chromosomes
4.) Microtubules retract, pulling chromosomes apart at the centromeres towards opposite ends of the cell
5.) Cell membrane pushes apart, and the nuclear membrane reforms around the two sets of chromatin
6.) Final result is two identical daughter cells

Meiosis

1.) DNA replication occurs as chromatin
2.) Chromosomes form, partner chromosomes exchange genetic material (called recombination)
    - Think partial-switching of chromosomes from father and mother
3.) Chromosomes line up at the centre line, microtubules occur, pull chromosomes apart (end of reduction division cell)
4.) Microtubules attach to obtain single chromosomes in each third generation, which become the ova (results in four daughter cells) (from sperm and ova

chromosomes exchange material and undergo this process to produce four daughter cells)

- Each of the four daughter cells are slightly different from one another due to the genetic recombination before the first cell division
- (Refer to textbook online in bookmarks for further clarification: she didn't do a very good job of explaining it)

Problems With Meiosis

- Nondisjunction
    - A chromosome doesn't separate correctly during the second stage of meiosis, which means a gamete might be missing, another might have an extra, etc
    - Can cause Monosomy where a zygote has only one copy of a chromosome
    - Can cause Trisomy, where a zygote has three copies of a chromosome (if a parent had an extra)
    - Usually causes an unviable embryo, which is eliminated from the body
    - Some monosomies or trisonomies don't disrupt the term of the fetus, for example trisomy 21 which results in Down Syndrome
    - Can also occur in reproductive chromosomes :

Genotype	**Gender**	**Syndrome**	**Physical Traits**
XXY, XXYY, XXXY	Male	Klinefelter Syndrome	Sterility, small testicles, breast enlargement
XYY	Male	XYY syndrome	Normal male traits, 7cm taller on avg., increased tendency for learning disabilities
XO	Female	Turner Syndrome	Sex organs don't mature at

			adolescence, sterility, short stature
XXX	Female	Trisomy X	Taller stature, learning difficulties, limited fertility

Why Is Meiosis Important For Evolution?

1.) Rapidly increases genetic variation in populations

2.) Provides genetic diversity for natural selection to act upon

DNA STRUCTURE

- When double helix is uncompressed, DNA structure looks like a ladder
- Nitrogen bases hold everything together in the centre of the structure (ATGC)
- Nucleotides have one sugar molecule, one phosphate molecule, which bond with one of the nitrogenous bases
- Thymine only binds with adenine, because they only have two H-bonds, and three H-bonds bind guanine and cytosine
- Bonding restrictions on one side of the structure allows for predictability of a mirror-type on the other side of the structure

1.) Replication

- DNA is a giant "recipe book" for all structures of the body
- This "recipe book" must be replicated before cells divide so each cell has a copy within them

2.) Protein Synthesis

- The code book has the instructions or "recipes" for how to make proteins
- Genetic codes are these isolated instructions, and are read by the ribosomes

DNA Replication

- Enzymes travel between nitrogenous bases and "unzips" the double helix

- Free floating nucleotides in the nucleus bond to both detached strands
- Final product are two identical double strands
- Cell now can divide
- Must occur while DNA is in chromatin form

Protein Synthesis
Proteins - Complex, 3D molecules composed of amino acids

Ribonucleic Acid (RNA)
- Ribose (sugar molecule)
- Uracil (U) instead of thymine (T)
- 3 types of RNA
    - Messenger (mRNA) - in the nucleus
        - Reads recipe on genetic code and sends it through the nuclear membrane outside the nucleus
    - Transfer (tRNA) - cytoplasm
    - Ribosomal (rRNA) - ribosomes

Protein Synthesis
Step 1 - Transcription
- DNA strands unzips
- Messenger RNA reads one side of the exposed DNA
- String of mRNA is produced, sends it to ribosomes

Step 2 - Translation
- Ribosomes reads mRNA transcription of the DNA
- Ribosome will read mRNA in groups of three (triplet codon)
- Start codon - methionine (should be the first amino acid)
- Stop codon releases the polypeptide chain, results in protein
- Only 20 different amino acids
- 11 amino acids are produced by the cell
- 9 are obtained by the foods we eat (essential amino acids)
- ~90 000 proteins which can be created by these amino acids
- Different codons can code for the same amino acid

Transcription/Translation Errors

- Substitution
    - Enzyme will accidentally knock out a nucleotide, and a free-floating nucleotide will take its place
- Insertion
    - Nucleotide accidentally inserted from one of these free floating nucleotides
- Deletion
    - Enzyme moves up the DNA strand, knocking out a nucleotide that doesn't get substituted by a free-floating nucleotide
- Errors lead to different proteins being produced, which means mutations
    - Point-mutations are one nucleotide errors

Genes

- Specific sequence of these nucleotides at a specific location on the DNA
    - Also known as locus for location
- Introns - Non-encoded DNA, 24% of genetic code removed from mRNA sequence
- Exons - Encoded DNA: regulating proteins, controlling gene expression, chromosomal structure
    - 2% of exons code for protein synthesis
    - 8% of exons directs embryonic development regulatory genes

Regulatory Genes

- Influences activation of which genetic codes
- Involved in physiological processes in a human life (i.e. lactase switched on at birth during breastfeeding)
- If you don't drink milk after weaning, turns of lactase
    - Ancestors with pastoral groups lactase persists
    - Ancestors with non-pastoral groups who don't drink milk are more likely to have lactose-intolerance

Homeobox Genes

- Evolutionarily ancient group of regulatory genes involved in regulation of patterns of anatomical development

- Code for homeodomain protein that regulate gene expression and cell differentiation during embryonic development
- 180 base pairs long

Neanderthal Genome Project 2006

- How different were neanderthal genes from human genes
- In 2010 the first whole Neanderthal genome is sequenced
- Bones and teeth of more recent Neanderthals 40 kya (DNA from teeth is the best source because they're not porous and are unlikely to become contaminated)
- What they found is that 99.7% similar to DNA of people living today (0.3% difference is Annunaki lol)
- Not a big difference genetically, but physiologically different
- Like humans, neanderthals are 98.8% similar to chimpanzees
- Genetic differences lies in functional elements (e.g. proteins)
- Resulting in differences in cognitive development, skull structure, energy metabolism, skin pigment, and wound healing
- Roughly 2% of individuals living in modern Europe and Asia can contain neanderthal DNA
- Humans and neanderthals shared a common ancestors about 80 000 years ago

MECHANISMS OF EVOLUTION: MENDELIAN GENETICS

Mendelian Genetics

- Gregor Johann Mendel (1822-1884)
    - Conducted experiments with self-pollinating pea plants
    - Father of modern genetics

Mendel's Pea Traits

- Crossed 7 different traits that appeared to be inherited independently of one another
    - Only seem to be expressed in one of two way
    - Traits included seed shape, colour, pod shape and colour, flower colour, position of flower on stem, stem length
    - Traits come in dominant and recessive forms

Mendel's Laws of Inheritance

1.) Principle of segregation:
    - Every organism contains two forms for each trait or variable
    - Each gamete contains one of these forms due to meiosis
    - During fertilisation, the next generation receives one form, inherited from each parent
2.) Principle of independent assortment:
    - Alleles for separate traits are passed independently from parent to offspring
    - Occurs during the genetic recombination phase of meiosis
    - Recombination is random
3.) Principle of dominance:
    - There are two types of traits or alleles, dominant and recessive
    - The dominant alleles will always mask recessive alleles
    - Not universally applicable (i.e. polygenetics)
    - Parental generation can be represented by P or F_0
    - Heterozygous: two different alleles
    - Homozygous: same allele
    - Polymorphism: many variations of a trait at different loci (where mendel genetics falls apart)

- Phenotype - trait(s) expressed physically
- Genotype - alleles present at a locus

Notation For Mendelian Genetics

- Letters that rep. Alleles are italicised (*T or t)* (MUST BE FOR MIDTERM)
- Heterozygous most be dominant first, because that's what's in the phenotype

Punnett Square

- One axis is one gametes' traits (e.g. *T t)*
- Second is the other (e.g. *T t)*

Mendelian Inheritance

Autosomal Dominant conditions (heterozygous) (50% chance of passing on to children)

- Marfan Syndrome (eye problems, cardiovascular problems, increased limb size, heart problems)
- Achondroplasia (a type of dwarfism)
- Neurofibromatosis (tumours to form on nerve tissue)

Recessive trait conditions (homozygous) (25%)

- Albinism
- Cystic fibrosis
- Sickle-cell anaemia
    - Normal hemoglobin (breeding ground for malarial parasite)
    - Sickle cells are resistant to malaria

Mendelian Inheritance

- Discrete traits/discontinuous
- Operate independently
- Recessive and dominant

Polygenic Inheritance

- Continuous traits
- Each locus has some influence on phenotype polymorphism
- Alleles occur at 2+ loci on different chromosomes
- Can be influence by environment

Continuous traits

- Skin colour, hair colour, height, face shape, finger print pattern, eye colour

Polygenic inheritance and the environment

Epigenetics - the study of changes in organism caused by modifications to gene depression from environmental stressors

Epigenetic trait - A stable heritable phenotype resulting from chromosomal change that does not alter the DNA sequence

Heritability - statistical method of testing out the contributions of genetics and environment to a phenotype

Environmental Effects Of Epigenetics

Maternal Influences

- Nutritional and physiological stress
- Transgenerational

Paternal Influences

- Paternal obesity

The Modern Synthesis Theory of Evolution

- Natural selection + changes in allele frequencies = biological evolution (production and redistribution of variation, natural selection acting on this variation)
- Natural selection operation on 4 levels
    - Molecular (genes themselves, which environments changing which forms get activated within genetic code)
    - Cellular (which gametes receives which traits due to genetic recombination)
    - Individual (Does the individual receive benefits)
    - Population (population benefits)
- Variation resides in alleles
- From a modern genetic perspective, evolution is a change in allele frequency from one generation to the next
- Allele frequencies are indicators of the genetic makeup of a population
- In a population, allele frequencies refer to the percentage of all possible alleles at a locus
- Changes in allele frequencies can result in:
    - Microevolution - small genetic changes that occur in a species
    - Macroevolution: large scale changes that occur after many generations (speciation)

HUMAN POPULATION GENETICS

Population - Group of interbreeding individuals who share a common gene pool
Exogamy - Breeding outside the community
Endogamy - Breeding within the community
Breeding Isolates - small interbreeding population, generate less diversity
Population Genetics - studying the frequency of genotypes, phenotypes, alleles, in populations

- Understanding microevolutionary changes in allele frequency

Polymorphism - phenotype due to the interaction of many alleles at many loci.

Temporary Adaptations

Acclimatization - temporary adaptations to the environment

- Tanning
- High altitude training

Negative Effects

- Melanomas - erratic growing melanocytes (skin pigment cells → cancer)
- Too little exposure to vitamin D limits hydroxyapatite development in bone
    - Rickets (children)
    - Osteomalacia (adults)

Factors That Redistribute Variation

Gene Flow (between a population)

- Exogamous breeding is required
- Exchange of genes between populations
- E.g. Neanderthals and humans
- Typically benefits both populations

Genetic Drift (within a population)

- Occurs in a smaller population
- Prevalence of high frequency alleles
- Low frequency alleles at risk of being eliminated from a population if breeding is endogamous
- Effects that reduce variation
    - Founder effect
        - Group of migrating population, containing a limited source of genetic variation from parent population, resulting in descendants being more like the migrating
    - Genetic bottleneck
        - Population size significantly reduced (due to natural disaster, large war, etc)

Adaptive Significance of Human Variation

E.g. Epicanthic folds (skin flaps of eyes)

Product of the genetic drift or the founder effect?

- Trait was present either phenotypically or genotypically in a population who migrated East?
- Trait is also visible among some First Nations

Human Variation - multi-generational effect of beneficial phenotypic traits in specific environment conditions

- Example is sweating (a particular human, and horse, trait)

Homeostasis - stable equilibrium of long-term adaptations

Bergmann's Rule:

- Larger trunk size in colder climates
- Reduce surface area for vasoconstriction
- Conserves body heat (opposite of vasodilation)

Allen's Rule:

- Longer limbs in warmer climates
- Better facilitates vasodilation
- Keeps core temperature down

Categorizing Human Variation

Carolus Linnaeus (1707-1778)

- H. sapiens Europeanus albescens: European "whites"
- H. sapiens Africanus negreus: African "black" people
- H. sapiens Asiaticus fucus: Asian "dark" people
- H. sapiens Americanus rubescens: "red" people from the Americans

Johann Friedrick Blumenbach (1752-1840)

- First to use comparative anatomy
- Skull shape
- Classified into 5 races
    - Mongolian
    - American
    - Caucasian
    - Malayan
    - Ethiopian
- Wrong because there is a large diversity of skull shape

FORCES OF EVOLUTION

- Mutation

- Gene FLow
- Genetic Drift
- Natural Selection
- Non-random mating (sexual selection)
- These are the 5 forces of macroevolution (speciation)

Sexual Selection

- Darwin's *Descent of Man, and Selection in Relation to Sex* (1871)
    - Sexual selection is non-random
    - Female choice
    - Male competition

Taxonomic Classification (Principles Of Similarities)

- Today = Genetic Similarities
- Similarities in homeobox gene anatomic development decide this (bone structure) (e.g. chicken and purpose to ancient reptilian species 5 digits forearm)
- Homologies - shared forms due to a common ancestry
- Ancestral traits - anatomical forms inherited from a common lineage (commonalities of homologies)
- Derived Traits - modified anatomical forms
- Divergent evolution - related animals split to become different species
- Analogies - similarities based on common function, with no common evolutionary descent (e.g. flight thus wings)
- Convergent evolution - separate evolutionary development of similar characteristics in different groups of organisms

Interpreting Relationships - Evolutionary Systematics

- Ancestor-descendant relationships (homologies) indicates which family group
- Ancestral traits determines degree of evolutionary relationship
- Mapped out in a phylogenetic tree, which is a map of evolutionary relationships across a timescale

Interpreting Relationships - Cladistics

- Clustering related formes into Clades (lineal descent from a common ancestor)
- Derived Traits
- Cladogram
- No time scale

Interpreting Relationship

Evolutionary Systematics

- Traditional approach
- Ancestors + descendants trace through time via analysis of homologies and ancestral traits

Cladistics

- Evolutionary interpretations based on environmental adaptation and analysis of specific types of derived traits

Biological Species Concept

- Species defined as groups of individuals who are capable of fertile interbreeding
- Reproductive isolation from other groups can lead to speciation
- Divergent evolution is what is meant by this
- Behavioural isolation (behaviour is different i.e. different mating behaviours)
- Geographic isolation (individuals who are physically separated)
    - Species as a group of organisms exploiting single ecological niche
- Allopatric speciation - speciation occurring because of geographic isolation
- Species recognition
    - Individuals identify members of own species for matin (& avoid mating with members of other species)

Parapatric Speciation

- Variable gene flow between two populations
    - Two troops of species meet in hybrid zones to mate
    - Hybrids have heterosis (hybrid vigour)

Phylogenetic Species Concept

- Splitting populations into separate species based on identifiable parental pattern of ancestry

Macroevolution

New species arise via:

- Anagenesis
  - One species changes over time into new species
  - Mostly gradual time
  - Barrier = time
- Cladogenesis
  - One species gives rise to 2 new species over time
  - Barriers = biological, behavioural, geographic, environmental
- Both can be:
  - Gradual evolution - slow over time
  - Punctuated equilibrium - fits and starts (flat, increase, flat, increase, think Physics and Chem law of energy and states of matter) → example would be cataclysmic event

1. **What was the key Darwin needed to explain how one species evolved from another? (refer to class notes)**

   Genetics

2. **What was the selective force in nature that Darwin used to develop his theory? (refer to class notes)**

   Competition

3. **What important moment occurred after the debate of the Advancement of Science meeting on June, 1860 between Huxley and Wilberforce?**

   The Church had taken a blow of sorts, Huxley winning the “debate” with Wilberforce, and so it provided an avenue for the intellectual aspect of European society to be headed by scientific thinkers, rather than diluted thought from the Church.

4. **How did German philosopher, Friedrich Nietzsche, react to Darwin’s theory?**

Believed it tore down Europe's old paradigm of God fearing society, and wanted to push the idea further and explore what truly held up a moral system together. He loved it: "God is Dead"

5. **How was Darwin's theory of natural selection used negatively during the Great War of 1914 by German intellectuals?**

Through Professor Kellog's discussions with the German high command in Northern France, it is now known that they viewed the evolutionary pressure of competition to be a driving force of their war. "[If Germany lost the war, then they are on the wrong evolutionary line and deserve to lose the war. If Germany won, then the rest of the world was on the wrong evolutionary line]".

6. **How did George Price apply Darwin's theory to explain the evolutionary logic of altruism?**

He created an equation, based on the idea that violence and acts of altruism serve biological purposes, which essentially said that "goodness does not come from God, and evil is bred in the bone". He essentially said that violence is as genetic as hair or eye colour.