

Human Evolution and Climate Change Part 1

The Human Timescale

- History of the earth in terms of a 12 hour clock

Species

- A population or a group of populations that are capable of interbreeding and that can produce viable and fertile offspring
- Mules are infertile as they are a mixture of two species (don't have the proper number of chromosomes)

Primate Ancestor

- Pen-tailed tree shrew
- Ecologically similar to squirrels
- Tree-dwellers among branches
- Eats fruit and insects
- See Primate evolution
- Chimp to humans started around 6 mill years ago

Primate Evolution

- Primates
 - Primitive, smaller bodies and brains: Prosimians
 - Lemurs and tarsiers
 - Larger bodies and brains: Simians/ Anthropoids
- See Primate Phylogeny

Prosimians and Monkeys

- Marmosets
- Tamarins
- Capuchins
- Howler
- Spider, etc

Family Hominidae: The Great Apes

- Orangutan
- Chimpanzee
- Gorilla
- Hominins
 - Gave rise to modern homosapiens

OUr Common Ancestor

- Probably had many traits in common with modern Chimps and Bonobos
 - Diet of fruit

- Lived in mixed habitats
- Used tools (manipulated objects in their environment for their advantage)
- Hunted small animals/ insects
- Culture (transmission of non-genetic traits)

Evolution of Brachiation

- Efficient way of moving around branches
- Accompanied by greater dexterity and diversity of uses of arms and hands
- Brachiation is a means of movement using primarily the upper limbs
- Feet and tails could be used as well
- Start of the manipulation of hands and feet to our advantage
- See evolution of the primate hand

Primate Hands and Feet

- Opposable thumbs and big toe
- Fingers and toes have flat nails
 - Favours finger dexterity and manipulation
 - Helps grab things
 - Exception: toilet claw

Primate Characteristics

- Reduced snout
 - Increased visual acuity instead
- Reduced number of teeth but increased diversity (heterodonty)
 - Incisors to shear
 - Canines to slice
 - Pre-molars to crush
 - Molars to grind

Primate Vision

- Eyes facing forwards
 - Binocular vision
 - Often developed by predators
 - Need more focus on distance
 - Depth perception and 3D
 - Well developed occipital lobe

Reduced Reproductive Rate

- Carrying offspring in trees
- Emphasis on care and learning

Evolution of Bipedalism

- Truly bipedal primates

- Comparing human skeletons to chimps
 - Chimps still use arms for brachiation
 - Positioning of foramen magnum is different
 - Chimps have prognathous appearance (jaw juts out)
 - Jaw sizes different due to diets
 - Chimps arms are longer than legs, human's arms are shorter than legs
 - Hand sizes are different (small hands for easier manipulation)
 - Spinal column has the lumbar curve (s-curve) giving upright posture
 - Chimps have a bell curve
 - Pelvic basin in chimps is elongated and longer, humans is more wide and compact to support weight
 - Knees are reoriented to support weight
 - Feet are more slender

Human Lineages

- See slide

Sub-Fam Hominae (7MYA)

- Sahelanthropus tchadensis
- Chad, Africa, 7-6 MYA
- Size of a chimp
- Probably bipedal
 - Ventral position of foramen magnum
- Many traits that allowed it to be in the hominin family
- Brain was 320-380 cc(cubic cm) modern humans is around 1300cc

Hominins

- Orrorin tugenensis
 - Kenya, Africa (6.2-5.6 MYA)
 - 20 specimen found
 - Not sure if direct human ancestor or side branch
 - Bipedal femur
 - Long fingers (arboreal)
 - Frugivorous or granivorous teeth
- Ardipithecus ramidus
 - Ethiopia, Africa (4.5-4.3MYA)
 - First complete skeleton (female)
 - Brachiating hands and arms
 - Opposable toe but flat foot adapted for walking
 - Brain size is 300-370cc
- Australopithecus afarensis (1973)
 - Tanzania, Ethiopia, Kenya (3.7-3MYA)
 - Hundreds of skeletons found

- Fully bipedal but also arboreal
- Pronounced sexual dimorphism
 - Sexes had noticeable physical differences (usually in terms of size)
 - Implies the different roles they were involved in
- Brain is 380-550cc
- The most famous fossil is Lucy, found by the Leakey's
- Tracks found in volcanic ash helped determine how they walk
 - Two walking side by side
- Paranthropus (3 species)
 - Ethiopia, Kenya, Tanzania (2.7-1.3MYA)
 - Lived in humid habitats
 - Sexual dimorphism
 - Principally bipedal
 - Broad teeth, large sagittal crest
 - Tough, herbivorous diet
 - Used stone tools
 - Brain size 474-545cc
 - Not directly related to modern humans, but showed many of the same characteristics
 - Coexisted with similar species but remained separate from contact with one another
 - More ape-like

Homo

- Smaller faces, jaw not prognathous
- Small molars but bigger incisors and canines
- Bigger brains
- Thorax and pelvis upright and slender
- Longer legs
- Shorter toes
- Culture
- Homo sapiens are the only species that still exists

Part Two

Molecular Evidence

- Humans and chimps/ bonobos share 95% of our DNA in common
- The 5% is responsible for the important difference in body, brains and behaviours
- Humans are a sub branch of the hominid family

Early Homo Evolution

- Up to 4 species (H. habilis, H. rudolfensis, H. ergaster, H. erectus)
- H. habilis and H. rudolfensis ~ 2.5-1.5MYA
- Brain >600cc

- Development of rudimentary tools
- Development of language and rudimentary culture

H. Habilis Tools

- Primitive Oldowan Tools
- Also found animal bones with scratches from tools
- Stones that are broken in different ways

Relationship with large Cats

- Main predators of hominins
- Caves found with chewed bones
 - Mostly Australopithecus, but also some coexisting Homos
 - Humans were more intelligent and capable of group defence
- Sabre-toothed tiger

Homo ergaster and Homo erectus

- 1.9-0.5 MYA
- Larger brain (~1000cc) and height (~1.85)
- Nomadism and migration out of Africa
- Discovered fire use
- More advanced tools developed

Ergaster/ Erectus Tools

- Acheulian Toolbox
- Small axes
 - Chopping wood for fire
- Stone flakes used as knives and blades

Ergaster/ Erectus Success

- Better competitor than earlier hominins
- The first to hunt large animals
- Drove many to extinction
 - Australopithecines
 - H. habilis
 - Sabre-toothed tigers
 - Mammoths

Fire and Migration

- Homo erectus/ ergaster first to use fire
- Permitted living in colder northern climates
 - North of China
- Fireplace could have been first stable social gatherings
 - Communication

- Cultural transmission
- Community development and stability

The Hobbit - Homo floresiensis

- Discovered recently on Flores Island in S. Pacific
- Small adult size (equivalent of modern 3 year old child)
- Dwarfism common on islands (limited resources, lack of predators)

Homo Neanderthalensis

- 200,000-28 000 YA
- Middle East and Europe
- Brains larger than modern humans (1400cc compared to 1300cc)
- Lived in caves and shelters
- Had well-developed culture
 - Burials with decoration

Neanderthal Anatomy

- Prominent face
- Teeth became very worn with age (used as tools)
- Thick and strong bodies
- Well adapted to cold climates

Relationship Sapiens-Neanderthal

- Not purely antagonistic
- Reproductive hybridization
 - Evidence that Neanderthal DNA found in European populations
 - Red hair is seen to be a trait
 - As well as dealing well with cold
 - Disease resistant traits
- Limited hunting abilities, no large animals
- No fishing (lacked hooks, nets, needles)
- Shorter lifespan so cultural transmission between generations was more limited

Neanderthal Tools

- Mousterian style
- Scraper
- Pointed darts for spears
- Copied modern human tools
 - Intermediate forms of tools
 - Did not have sophistication of modern H. sapiens tools

Neanderthal Extinction

- First human genocide

- Adapted to cold climates, unlikely due to glaciations

X-Y Chromosomes & Genetic Adam

- Y chromosome determines the male sex
- Tracing the Y chromosome as far back as possible to find a common ancestor
- Data has shown the first human was around 250,000 years ago, which corresponds with the previous assumptions

Mitochondrial Eve

- Mitochondria is only passed down through maternal lineage
- Evidence shows that she existed around 250,000 years ago as well

Homo sapiens

- Modern humans
- Emerged around 200,000-130,000 YA
- Composite tools
- Good Cooperative hunters
- Cooperative culture, language and art well-developed

Global Migration of Modern Humans

Pleistocene Extinctions

- At around ~11,000YA several species of large animals went extinct
- For the most part, they were well adapted to cold climates
- In Eurasia: Giant Elk, Hairy Rhinoceros
- North America: Mastodon, Sabre-toothed tiger
- Himalayas: Giant Ape (Gigantopithecus)
- Possible Origin of Yeti/ Bigfoot mythology
- In North America
 - Mastodons
 - Mammoths
 - Giant sloth
 - Giant Bison
- Principal hypothesis
 - Overhunting (Pleistocene Overkill Hypothesis)
- Evidence
 - Mostly large mammals and birds affected
 - Extinctions in different places at different times
 - Extinctions correlated with sudden arrival of humans

Humans in North America

- Arrived ~12,500-11,000 YA during glacial period (Bering land bridge)
- All N.Am Aborigines have relatively homogenous genetic diversity due to founder effect

- Showed susceptibility to European diseases upon arrival of colonists
 - Used this to try to kill off the aboriginals
- Excellent group hunters
 - Mammoths, mastodons, Giant sloth, Bison
- Facilitated extinction of large predators due to lack of prey food (ex large cats)
- Clovis tools
 - Ex Atl-Atl

Pleistocene Humans

- Hunters and gatherers over large distances
- Required certain amount of nomadism
- Hippocampus well developed due to spatial perception

Cro-Magnon Artwork

- Multi-colour carve paintings in Lascaux which show many animals now extinct
- Figurines to model female fertility (Venus)
- Instruments: flutes, shakers

Why the Great Leap in Modern Humans?

- Factor #1: Language
 - Anatomy of the larynx, tongue and throat allowed for great diversity of sounds
 - Allowed for instantaneous transmission of information, without reliance on demonstration
 - More cultural evolution occurred in the last 40,000 yrs than in previous millions
- Factor #2: Changes in lifecycle
 - Reduced reproduction
 - Bi-parental care
 - Long lifespan
- Allowed for long periods of learning required for living a complex life
 - Required much care, protection and teaching
- Consequences of monogamy and parental care:
 - Community stability
 - Development of societies
- Advantages to living in groups
 - Coordinated hunting
 - Harvesting of fruit, nuts and plants over greater distances
 - Better protection from predators

Agriculture to Civilization

- About 10,000 YA
- Origin in Middle East
- Allowed us to stay in one spot and produce large amounts of supplies to support community

- Allowed infrastructure
- Move from nomadism to sedentary
- Industrialization happened in mid 1800's
 - Use of fossil fuels

Carbon Cycle

- Leading to climate change
- Sources of carbon dioxide in the atmosphere
- Photosynthesis is the main process to remove carbon from the atmosphere

Greenhouse Effect

- A natural and necessary process
- Short wave radiation
 - Absorbed by earth
 - Re-emitted as longwave radiation
 - Long wave gets trapped in atmosphere
 - Light comes in, but heat can't get out

CO2 and Temperature Increases

Periodic Glaciations (~2.5 MY)

- We have been in glacial period since the end of the Tertiary
- Continental glaciations have advanced and withdrawn 17x in the last ~2MY
- Evidence
 - Microfossil communities (associated with different temperatures)
 - Moving coastlines as seas rise and fall (~70m)
 - Scarified bedrock
 - Large moraines and rock deposits

Climate Change

- Rising sea levels