

HUMAN EVOLUTION – Notes for Human biology course

1. Introduction

Human biology

- the exploration of human **diversity in time and space**
- the study of the whole of the human condition: past and present
- the study of diversity that comes through human adaptability (**adaptation**: the processes by which organisms cope with environmental forces and stresses)
- the academic discipline of human biology / anthropology includes four main subdisciplines or subfields: biological/physical anthropology, sociocultural anthropology, archaeology, linguistic anthropology

Biological anthropology examines:

- how humans adapt to diverse environments
- how biological and cultural processes work together to shape growth, development and behaviour
- what causes disease and early death
- human biological origins, evolution and variation
- other primates (primatology), the fossil record (paleoanthropology), prehistoric people (bioarchaeology)
- the biology (health, cognition, hormones, growth and development) and genetics of living populations

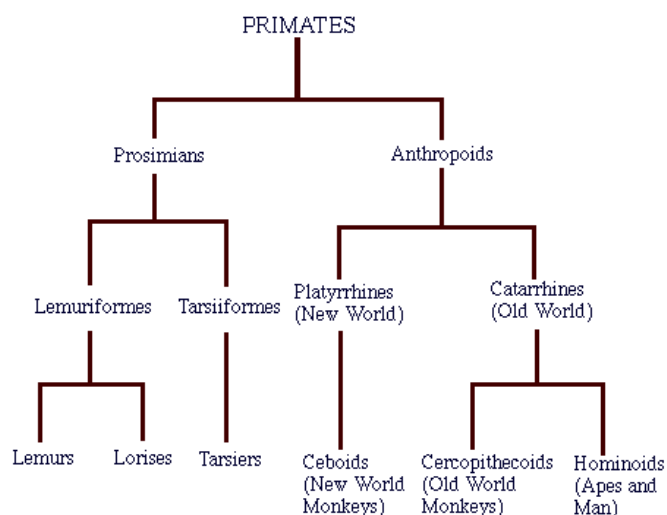
Human biology-research fields

- paleoanthropology:
 - the study of human evolution
 - the understanding of the similarities and differences between humans and other species in their genes, body form, physiology, and behaviour
- racial classification
- human ontogeny
- applied anthropology

2. Human evolution

- the lengthy process of change by which people originated from apelike ancestors
- the physical and behavioral traits shared by all people originated from apelike ancestors and evolved over a period of approximately 6 million years
- **Primates**: the 3rd most diverse order of mammals, after rodents (Rodentia) and bats (Chiroptera)
- any mammal of the group that includes the lemurs, lorises, tarsiers, monkeys, apes and humans
- **Primates classification**

- **Primates**: although there are some notable variations between some primate groups, they share several anatomic and functional characteristics reflective of their common ancestry



Primates: Anthropoids (Hominoidea) and Prosimians

- diversified in arboreal habitats
- characteristics that are adaptations to this environment:
 - five digits on the limbs (opposable thumbs and big toes)
 - nails on the fingers and toes
 - orbits encircled in bone
 - a reliance on vision at the expense of olfaction
 - a complex visual system with stereoscopic vision
 - a large brain in comparison to body size
 - reduced number of teeth (compared to primitive mammals)
 - two pectoral mammary glands
 - long gestational and developmental periods
- **Prosimii subordo (Prosimians)**
 - Primates that include lemurs, lorises, bushbabies, and tarsiers, but not monkeys, apes, or humans
 - Prosimians are the only primates native to Madagascar, but are also found throughout Africa and in Asia
 - their brain are markedly smaller than those of simians of comparable sizes
 - diets typically are less dominated by fruit
 - many are active arboreal predators in the trees
 - most of them are nocturnal
 - small body size
 - rhinarium (a moist, naked surface around the nostrils of the nose)
 - Prosimians usually have litters rather than single offspring
- **Anthropoidea subordo**
 - „higher primates”:
 - the Old World monkeys (including humans) – the Catarrhines
 - the New World monkeys – Platyrrhines
 - their brain are bigger than those of Prosimians
 - most of them are diurnal
 - bigger body size
 - they usually have single offspring than litters
- humans bear particularly close affinity to other members of a group known as hominoids, or apes, which includes orangutans, gibbons, gorillas, chimpanzees and humans
- *Homo sapiens* share clear anatomical, genetic, and historic relationships to other primates

Humans and their immediate ancestors: hominins

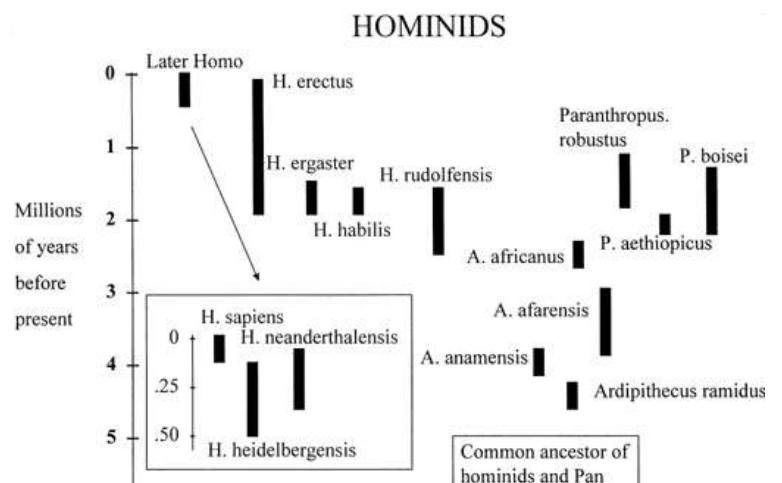
- bipedal locomotion, slow rate of maturation, large brain size, development of a relatively sophisticated capacity for language, tool use, and social activity (among the more recent hominids)
- one of the earliest defining human traits, bipedalism evolved over 4 million years ago
- other important human characteristics (large and complex brain, the ability to make and use tools, and the capacity for language) developed more recently
- many advanced traits (including complex symbolic expression, art, and elaborate cultural diversity) emerged mainly during the past 100,000 years
- humans and the great apes of Africa (chimpanzees and gorillas) share a common ancestor that lived between 8 and 6 million years ago
- humans first evolved in Africa, and much of human evolution occurred on that continent
- the fossils of early humans who lived between 6 and 2 m years ago come entirely from Africa
- anthropologists currently recognize some 15 to 20 different species of early humans
- scientists do not all agree, however, about how these species are related or which ones died out
- many early human species left no living descendants
- scientists also debate over how to identify and classify particular species of early humans, and about what factors influenced the evolution and extinction of each species

The hominin lineage (milestones):

- Australopithecina: Australopithecus anamensis, Australopithecus afarensis, Australopithecus africanus, Australopithecus garhi, Australopithecus aethiopicus, Australopithecus robustus, Australopithecus boisei,
- Homo species: Homo habilis, Homo erectus, Homo neanderthalensis, Homo sapiens

Australopithecus species

- specimens recovered only from Africa
- anatomy adapted to bipedal locomotion (characteristics suggest they were adapted to climbing trees)
- high brachial index (forearm/upper arm ratio) relative to other hominids
- sexually dimorphic to a degree greater than Homo and Pan, but less than Gorilla or Pongo
- height: 1.2–1.5 m, mass: 30–55 kg
- cranial capacity: 350–600 cm³
- postcanine dentition relatively large, enamel thickened compared to contemporary apes and humans
- incisors and canine relatively small, little sexual dimorphism in canines compared to modern apes
- tool-using capabilities
- two main groups of australopithecines: gracile and robust
- the difference between gracile and robust australopithecines are not so much the size of their bodies, but differences in the size of their faces and teeth
- robust australopithecines had large, wide faces and very large molars that were adapted to eating very tough foods –tubers, seeds, nuts
- **gracile Australopithecines:**
 - Australopithecus anamensis
 - Australopithecus afarensis
 - Australopithecus africanus
 - Australopithecus garhi
- **robust Australopithecines:**
 - Australopithecus aethiopicus
 - Australopithecus robustus
 - Australopithecus boisei



Australopithecus ramidus

- Eastern Africa (Middle Awash and Gona, Ethiopia)
- 4.4 m years ago
- tree-climbing and bipedal activity
- very little difference in size between males and females (120 cm, 50 kg)
- 300 and 350 cm³ brain size

Australopithecus afarensis

- Eastern Africa (Ethiopia, Kenya, Tanzania)
- 4-3 m years ago
- ape and human characteristics: apelike face proportions, brain size: 500 cm³, long, strong arms adapted for climbing trees, small canine teeth like all other early humans, regularly walked upright
- sexual dimorphism: males – 150 cm, 40 kg
females – 100 cm, 30 kg

Australopithecus africanus

- Southern Africa, 3.5-2 m years ago
- human-like and ape-like features: ape: relatively long arms and a strongly sloping face, human: rounder cranium with a larger brain (500 cm³) and smaller teeth
- *A. africanus* walked bipedally, but they were also adapted for climbing
- sexual dimorphism: 140 – 115 cm, 40 – 30 kg

Australopithecus anamensis

- Eastern Africa (Lake Turkana, Kenya and Middle Awash, Ethiopia), 4.2-3.9 m years ago
- shares many traits with *Australopithecus afarensis* and may well be its direct predecessor
- ape-like crania and dentition, rather advanced postcrania, more or less typically hominid-like in form, size of female chimpanzee with strong sexual dimorphism

Australopithecus boisei

- Eastern Africa, 1.1-2.6 m years ago, 500-550 cm³
- robust jaw, sagittal crest, heavy postcanine teeth, thick tooth enamel, and a flaring zygomatic arch, but the canines and incisors are similar to a human's,
- sexual dimorphism: 1.3-1.0 m, 70-45 kg

Australopithecus robustus

- South Africa, 1.2-2.3 m years ago, 410-530 cm³
- robust jaw, sagittal crest, heavy postcanine teeth, thick tooth enamel, and a flaring zygomatic arch, sexual dimorphism: 1.2-1.0 m, 54-40 kg

Homo habilis

- Eastern and Southern Africa, 1.4-2.4 m years ago, 550-700 cm³
- *H. habilis* had a slightly larger braincase and smaller face and teeth than in *Australopithecus* species, they still retained some ape-like features: long arms and a moderately-prognathic face
- the first stone-tool maker, 100-135 cm, 30 kg

Homo erectus

- they originated in Africa and spread as far as England, Georgia, India, China and Java
- 1.8-0.15 m y ago, 850-1100 cm³, they were extraordinarily slender, with long arms and legs
- frontal bone was less sloped and the dental arcade smaller than the australopithecines'
- the face is more orthognatic than either the australopithecines' or *H. habilis*'s, with large brow-ridges and less prominent zygomata
- Oldowan technology and later progressed to the Acheulean
- controlled use of fire, the first hominid who lived in a hunter-gatherer society

Homo neanderthalensis

- Europe and South Western to Central Asia, 600,000-28,000 years ago, 1200-1700 cm³
- 165-155 cm, 65-55 kg, large middle part of the face, angled cheek bones, a huge nose
- their bodies were shorter and stockier than *H. sapiens* (an adaptation to living in cold environments)
- they used a diverse set of sophisticated tools, controlled fire, lived in shelters, made and wore clothing, were skilled hunters of large animals and also ate plant foods, and occasionally made symbolic or ornamental objects
- Neanderthals buried their dead and occasionally even marked their graves with flowers
- possibility of interbreeding of Neanderthals with Cro-Magnon people (*H. sapiens*)

Homo sapiens

- evolved in Africa, now worldwide, appeared 500 (archaic) - 200,000 (modern) years ago
 - 1300-1400 cm³, lighter build of their skeletons compared to earlier humans
 - thin-walled, high vaulted skull with a flat and near vertical forehead
 - modern human faces also show much less of the heavy brow ridges and prognathism of other early humans, the jaws are also less heavily developed, with smaller teeth
 - *Homo sapiens* not only made and used stone tools, they also specialized them and made a variety of smaller, more complex, refined and specialized tools including composite stone tools, fishhooks and harpoons, bows and arrows, spear throwers and sewing needles
 - within the past 12,000 years *Homo sapiens* made the transition to producing food and changing our surroundings
 - they could control the growth and breeding of certain plants and animals
 - this discovery led to farming and herding animals, activities that transformed Earth's natural landscapes, as humans invested more time in producing food, they settled down
 - villages became towns, and towns became cities
 - with more food available, the human population began to increase dramatically
 - they had control over fire, they lived in shelters
 - they built broad social networks, sometimes including people they have never even met
 - they exchanged resources over wide areas; and they created art, music, personal adornment, rituals, and a complex symbolic world
 - modern humans have spread to every continent and vastly expanded their numbers
 - human races evolved
 - the term anatomically modern humans in paleoanthropology refers to individuals of *Homo sapiens* with an appearance consistent with the range of phenotypes in modern humans
 - anatomically modern humans evolved from archaic *Homo sapiens* about 200,000 years ago
- **archaic *Homo sapiens***
 - a diverse group of humans which have features of both *Homo erectus* and modern humans
 - the brain size is larger than *erectus* and smaller than most modern humans: 1200 cm³
 - the skull is more rounded than in *erectus*, the skeleton and teeth are usually less robust than *erectus*, but more robust than modern humans
 - many still have large brow ridges and receding foreheads and chins
- **anatomically modern *Homo sapiens***
 - had become dependent on technology rather than on raw physical power to meet the challenges of their environment
 - with the emergence of anatomically modern humans, the brow ridges had reduced, and in modern humans they are, on average, barely visible
 - another distinguishing feature of AMH is a prominent chin
 - commonly have a vertical forehead whereas their predecessors had foreheads that sloped backwards
 - the vertical forehead in humans not only houses larger brains, but the prominent forehead plays an important role in human communication through eyebrow movements and forehead skin wrinkling
 - AM *Homo sapiens* are supposed to have appeared in East Africa around 200,000 years ago
 - from there they spread around the world
 - from Africa over the Arabian Peninsula around 125,000 years ago brought modern humans to Eurasia, with one group rapidly settling coastal areas around the Indian Ocean and one group migrating north to steppes of Central Asia
 - 100,000-80,000 years ago, three main lines of *Homo sapiens* diverged in Africa:
 - to Central and West Africa
 - to southern Africa
 - to eastern Africa
 - the origin of modern human migration was located in south-western Africa



Migration of *H. sapiens* from Africa

3. Human races

- the migration groups were small, founder effect over the last 50,000 to 100,000 years probably accounts for much of the genetic variation we see among human populations today
- researchers have traditionally classified populations
- according to how various traits such as skin colour, hair colour, hair form, eye colour, and shape of the face and nose are combined
- people with particular combinations of these and other traits have been placed together in categories associated with
- specific geographical localities, such categories are called human races
- sustained reproductive isolation of human populations exposed to differing environments led over time to the evolution of distinct human races
- adaptation to environmental factors:

Bergmann's rule: describes the relationship of body mass or volume to surface area, in mammals body size tends to be greater in populations that live in colder climates, as mass increases, the relative amount of surface area decreases proportionately, heat is lost at the surface, it follows that increased mass allows for greater heat retention and reduced heat loss

Allen's rule: describes the relationship of body proportions or length of appendages to climate, in colder climates, shorter appendages, with increased mass-to-surface ratios, are adaptive because they're more effective at preventing heat loss; conversely, longer appendages, with increased surface area relative to mass, are more adaptive in warmer climates because they promote heat loss

Adaptation to environmental factors: according to these rules, the most suitable body shape in hot climates is linear with long arms and legs. In a cold climate, a more suitable body type is stocky with shorter limbs: in colder climates, body mass tends, on average, to be greater and characterized by a larger trunk relative to arms and legs; sub-Saharan Africans, especially East African pastoralists, are, on average, tall and linear

At **high altitudes**, many factors produce stress on the human body:

- hypoxia (reduced available oxygen), more intense solar radiation, cold
- low humidity, wind (which increases cold stress), a reduced nutritional base
- rough terrain, to obtain the same amount of oxygen at higher altitudes (from 3,000 m above the sea level) people must make certain physiological alterations that increase the body's ability to transport and efficiently use the oxygen that's available
- at high altitudes reproduction is affected through increased infant mortality rates, miscarriage, low birth weights, and premature birth; one cause of foetal and maternal death is a severe elevation of blood pressure in pregnant women after the 20th gestational week
- residents of high altitudes grow somewhat more slowly and mature later
- they have greater lung capacity and a relatively larger heart
- they have proportionally greater trunk dimensions

Negroid race group

- curly black hair
- dark brown skin, brown eyes
- scanty to moderate tertiary hair cover
- moderately prominent cheekbones
- strongly protruding jawbone (prognathism)
- slightly protruding, broad nose, with nostrils parallel to the facial plane
- thick lips
- long (dolichocephalic) head
- (except for pygmies) typically of fair stature, and the body and limbs slender.
- races: sudanid, nilotid, khoisainid, ...

Australid race group

- according to the 'Out of Africa Theory', Proto-Australoids (believed to be ancestors of the Australoid races) are thought to have migrated from the African continent and moved along the Southeast Asian coast towards the Australian landmass
- Australoid peoples ranged throughout Indonesia, Malaysia, Australia, New Guinea, Melanesia, Andaman Islands, Bangladesh, India
- fair stature with well-developed torso and arms, and slender legs
- the color of the skin is a shade of chocolate-brown or black
- the eyes are very dark brown or black
- the hair is usually raven-black, not woolly, but fine and silky in texture, wavy, and long
- the beard in males is well developed, as is the hair upon the body and the eyebrows
- male pattern balding is relatively common
- they are typically dolichocephalic (narrow-headed)
- the brow-ridges are strong and prominent
- broad nose
- heavy jaws, thick lips
- the face tends to prognathism
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Europid race group

- skin colour amongst Caucasoids ranges greatly from pale, reddish-white, olive, through to dark brown tones
- a broad range of eye colour (from brown to light gray and blue)
- a heavy tertiary hair cover
- hair texture that varies from straight to curly with a broad range of colours
- nose tends to be long and narrow
- skull presents all varieties of forms and can be dolichocephalic, mesocephalic, or brachycephalic
- little or no prognathism
- races: nordic, mediterranean, dinaric, alpic

Mongolid race group

- yellow or yellow-brown skin
- flat and small nose
- eyes have an epicanthal fold (giving a characteristic narrow, almond-shaped eye shape) and are black or dark brown
- black and straight hair, scanty on the body and face
- flat face with prominent cheekbones
- slight built and very lean musculature
- relatively short extremities
- races: eskimos, Southern Mongolians, ...