Chapter 14: PRIMATE EVOLUTION
PRIMATES
What is a primate?

Features that are unique to primates:
- Present in primates
- Absent in closely related groups

Outgroup

Ingroup

Character A present

Character A absent

Synapomorphy
What is a primate?

- Arboreal life:
  - Grasping hands and feet
  - Opposable thumb and big toe
  - Movable arms
  - Nails

- Visual system:
  - Depth perception
  - Large brain size

- Reproductive biology:
  - High parental investment
  - Single-offspring births
  - Long infancy
  - Delayed sexual maturation
Primates: main transitions

10 Mya
- Ground dwelling
- Vegetarian or omnivorous
- Large body size
- Long life span

20 Mya
- Vegetarian diet
- Sexual dimorphism

30 Mya

40 Mya
- Diurnal
- Insectivorous and frugivorous diet
- Expansion of neocortex
- Fovea

50 Mya
- Arboreal life
- Nocturnal
- Insectivorous diet
- Encephalization
- Temporal lobe
- Binocularity
- Grasping hands-feet

60 Mya

70 Mya

Humans

African apes

Proconsul

Old World monkeys

Aegyptopithecus

New World monkeys

Tarsiers

Lemurs, lorises

Adapis

Plesiadapiformes

Purpatorius

Insectivore or dermopteran ancestors
Primate taxonomy

Order: Primates
Suborder: Prosimians

- Lemurs
  (Madagascar)

- Lorises, galagos
  (Tropical forests of Asia, Africa)

- Tarsiers
  (Tropical forests of Borneo, Sumatra, Sulawesi, Philippines)
Autosomal gene-sequencing data

- Present
  - 4.5 Mya
  - 8 Mya

- 10 Mya
  - 31 Mya

- 20 Mya
  - 30 Mya

- 40 Mya
  - 50 Mya

- 50 Mya
  - 60 Mya

- Humans
  - Chimpanzees
  - Gorillas

- Old World monkeys

- New World monkeys
Primate taxonomy

Order: Primates
Suborder: Anthropoids

-Platyrrhins
-Catarrhins

Cercopitecines

Apes

Humans

South America
Africa, Asia, Europe

chimpanzees
gorillas

chimpanzees and gorillas
gibbons and orangutans

Humans
Asian apes

Gibbon

Orangutan

Siamang
Once widespread throughout equatorial Africa and Southeast Asia, ape populations have been reduced to fragmented pockets. Their chief habitats lie in forests under siege by loggers and by the inexorable human need for cropland. War in Southeast Asia pushed several of the nine gibbon species onto the endangered list. Also endangered, the orangutan is now found only in Sumatra and Borneo and numbers no more than 20,000.

In Africa 320 mountain gorillas survive, vulnerable at any time to extinction by poaching or disease. Lowland gorillas number fewer than 50,000.

The count for bonobos is 10,000 to 20,000 animals, all within Zaire, a nation plagued by civil unrest.

The chimpanzee population has been reduced to about 200,000 animals scattered in 21 nations. Only three countries—Zaire, Gabon, and Côte d’Ivoire—count populations of more than 10,000 each.

The very survival of the remaining wild apes may depend on the creation of well-patrolled reserves and a halt to the international ape trade.
African apes

Gorilla

Chimpanzee

Bonobo
What is an ape?

Relative to monkeys, apes:

- Lack an external tail
- Have a more vertical posture
- Have highly flexible limbs
- Have broad chests, short lower backs, mobile hips and ankles
- Have a larger body size
- Exhibit retarded growth and reproduction
- Have larger brains than monkeys
What is a hominin?

A hominin is a bipedal ape.
### Divergence between African apes and hominins

<table>
<thead>
<tr>
<th>Trait</th>
<th>Function</th>
<th>Chimpanzees</th>
<th>Hominins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foramen magnum and Occipital condyle</td>
<td>Posture</td>
<td>Behind skull</td>
<td>Beneath skull</td>
</tr>
<tr>
<td>Vertebrate column</td>
<td>Posture</td>
<td>C-shaped</td>
<td>S-shaped</td>
</tr>
<tr>
<td>Feet</td>
<td>Posture</td>
<td>Grasping</td>
<td>Flat</td>
</tr>
<tr>
<td>Pelvis, lower back</td>
<td>Posture</td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td>Brain size</td>
<td>Brain evolution</td>
<td>345-505 cm³</td>
<td>400-1350 cm³</td>
</tr>
<tr>
<td>Face</td>
<td>Brain evolution</td>
<td>In front of brain</td>
<td>Beneath brain</td>
</tr>
<tr>
<td>Canines</td>
<td>Sexual behavior</td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td>Diastema</td>
<td>Diet</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

- **Pliocene**: ~5 Mya
- **Miocene**

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EARLY HOMININS
Early specimens of uncertain hominin status

- Chimp
- Bonobos
- *Sahelanthropus tchadensis*
- *Orrorin tugenensis*
- *Ardipithecus ramidus*
- *Homo sapiens*

5-7 Mya

Bipedalism
Early specimens of uncertain hominin status

**Sahelanthropus tchadensis:**
*~6.5 Mya
*From Chad, central Africa (not eastern Africa!)
*Less prognathism (typical of hominids)
*Bipedalism uncertain

**Orrorin tugenensis:**
*~5.8 Mya
*From Kenya, eastern Africa
*Lower jaw fragment
*Bipedalism uncertain
Ardipithecus ramidus: oldest known hominin

http://www.youtube.com/watch?v=EC9alT1ah4
Ardipithecus ramidus: oldest known hominin

- 4.4 Mya
- From Ethiopia, eastern Africa
- Bipedal locomotion
- Grasping bit toe
- Small brain
Ardipithecus ramidus: oldest known hominin

- Long arms, suggest arboreal life
- Opposable big toe
- Relatively small brain
- Relatively small canines
- Long flexible lower back
- Long pelvis
- Height: 117-124 cm
- Weight: 51 Kg
Robust australopithecines

**Australopithecus afarensis**
*1.8 Mya
*Kenya

**Australopithecus aethiopicus**
*2.5 Mya
*Kenya

**Australopithecus boisei**
*3.0-3.6 Mya
*Tanzania, Ethiopia

**Australopithecus robustus**
*2 Mya
*South Africa
Gracile australopithecines

- Australopithecus afarensis
- Australopithecus africanus
- Australopithecus garhi

- *3*-2 Mya
  - *South Africa*

- *3.0*-3.6 Mya
  - *Tanzania, Ethiopia*

- *2.5 Mya*
  - *Ethiopia*

- Homo
HOMO
Early Homo

Chimp    Bonobos

Australopithecus
anamensis
*4.1 Mya
*Kenya

Australopithecus
afarensis
*3.0-3.6 Mya
*Tanzania, Ethiopia

Gracile

Robust

Homo
*2.3-2.5 Mya
*Tanzania, Ethiopia

Stone tools
Cranial capacity > 600 ml

Bipedalism

5-7 Mya
Hominin evolution: a brief survey

Evolution - Becoming Human (Donald Johanson)

http://www.youtube.com/watch?v=HphLBNGCBNk
Oldowan technology (Olduvai Gorge, Tanzania, Africa)
Gracile australopithecine

Homo habilis

H. rudolfensis

H. ergaster

*1.8-1.9 Mya
*Kenya

*1.6-1.9 Mya
*Tanzania, Kenya

Early Homo
Homo ergaster
Homo ergaster: Acheulean technology, 1.4 Mya, Ethiopia
H. antecessor
*0.8 Mya
*Spain

H. heidelbergensis
*0.6-0.2 Mya
*Zambia, Europe

H. ergaster
*1.8-1.9 Mya
*Kenya

H. erectus
*1.8-0.2 Mya
*Asia: Georgia, Java, China
*Oldowan technology

Archaic humans
Homo floresiensis

Flores Island (Indonesia)

H. ergaster

H. heidelbergensis

H. sapiens

H. floresiensis

H. erectus
Abstract: Because the cranial capacity of LB1 (Homo floresiensis) is only 417 cm(3), some workers propose that it represents a microcephalic Homo sapiens rather than a new species. This hypothesis is difficult to assess, however, without a clear understanding of how brain shape of microcephalics compares with that of normal humans. We compare three-dimensional computed tomographic reconstructions of the internal braincases (virtual endocasts that reproduce details of external brain morphology, including cranial capacities and shape) from a sample of 9 microcephalic humans and 10 normal humans. Discriminant and canonical analyses are used to identify two variables that classify normal and microcephalic humans with 100% success. The classification functions classify the virtual endocast from LB1 with normal humans rather than microcephalics. On the other hand, our classification functions classify a pathological H. sapiens specimen that, like LB1, represents an approximately 3-foot-tall adult female and an adult Basuto microcephalic woman that is alleged to have an endocast similar to LB1’s with the microcephalic humans. Although microcephaly is genetically and clinically variable, virtual endocasts from our highly heterogeneous sample share similarities in protruding and proportionately large cerebella and relatively narrow, flattened orbital surfaces compared with normal humans. These findings have relevance for hypotheses regarding the genetic substrates of hominin brain evolution and may have medical diagnostic value. Despite LB1’s having brain shape features that sort it with normal humans rather than microcephalics, other shape features and its small brain size are consistent with its assignment to a separate species.
DWARFS AND GIANTS tend to evolve on islands, with animals larger than rabbits shriveling and animals smaller than rabbits growing. The shifts appear to be adaptive responses to the limited food supplies available in such environments. Stegodon, an extinct proboscidean, colonized Flores several times, dwindling from elephant to water buffalo proportions. Some rats, in contrast, became rabbit-sized over time. *H. floresiensis* appears to have followed the island rule as well. It is thought to be a dwarfed descendant of *H. erectus*, which itself was nearly the size of a modern human.
Homo neanderthalensis: reconstruction
Recent hominid evolution

H. neanderthalensis
*130-28 Kya
*Europe, Middle East
*Mousterian technology

H. sapiens
*<200 Kya
*Ethiopia, South Africa, worldwide

H. heidelbergensis
*0.6-0.2 Mya
*Zambia, Europe
Homo neanderthalensis: Culture

• Europe, Middle East
• Intentional burials
• Clothing
• Fire
• Care of the injured
• Hunting
• Brain size: 1,200-1,750 cm$^3$
• Mousterian technology
Homo neanderthalensis: Mousterian technology, < 100 Kya, Europe

- Hand axe
- Bifacial point
- Borer
- Burin
Recent hominid evolution

H. heidelbergensis
*0.6-0.2 Mya
*Zambia, Europe

H. neanderthalensis
*130-28 Kya
*Europe, Middle East
*Mousterian technology

Denisovans
*40 Kya
*Siberia

H. sapiens
*<200 Kya
*Ethiopia, South Africa, worldwide
Multiregional hypothesis

Anatomically modern *H. sapiens* genes arise in many populations

*H. erectus* disperses from Africa
Homo sapiens: the “out-of-Africa” hypothesis
The human lineage

Haikouichthys
530 Mya

https://www.youtube.com/watch?v=hSSzn4blwZg