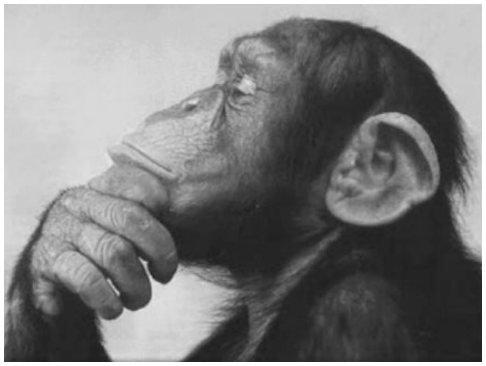
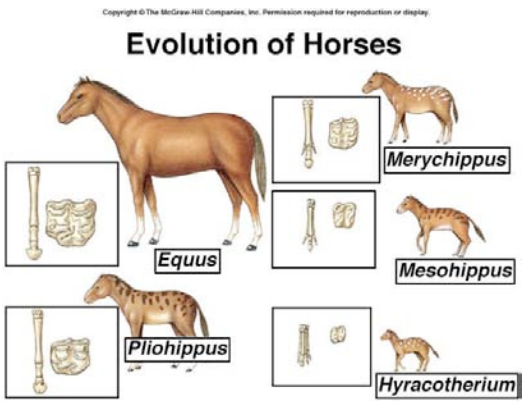
Primer on Human Origins

- Theories of Evolution - The various theories of evolution and human origins.
- The Evidence - The material evidence related to evolution.
- The Future - Broader issues related to human origins, cosmology and the future of our little species.



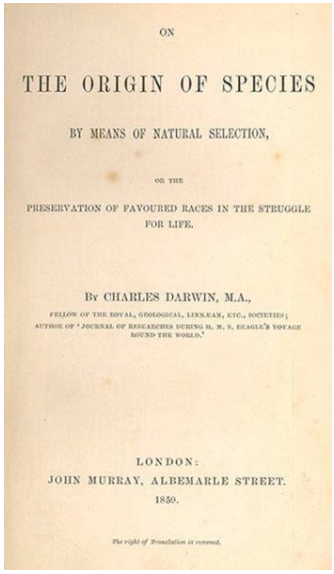
Evolution: Pattern & Process



"Evolution is the name we give both to *patterns of change* in the forms of life we observe, and to the *process of natural selection* that produces these patterns."

-- Philip Gingerich 2001

"light would be
thrown on the origin of man
and his history"



ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

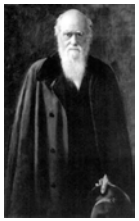
By CHARLES DARWIN, M.A.,

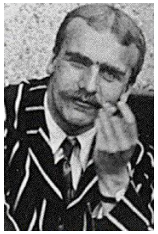
FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

3

Modern Synthesis



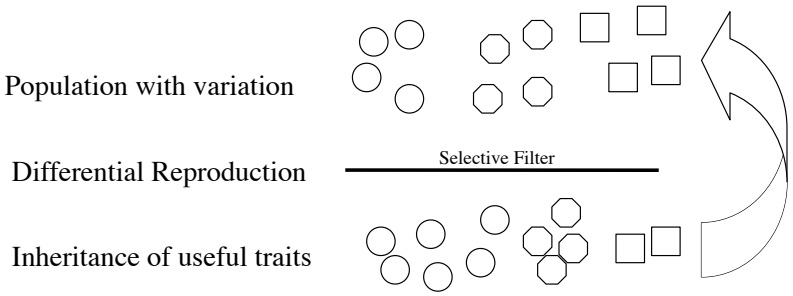


4

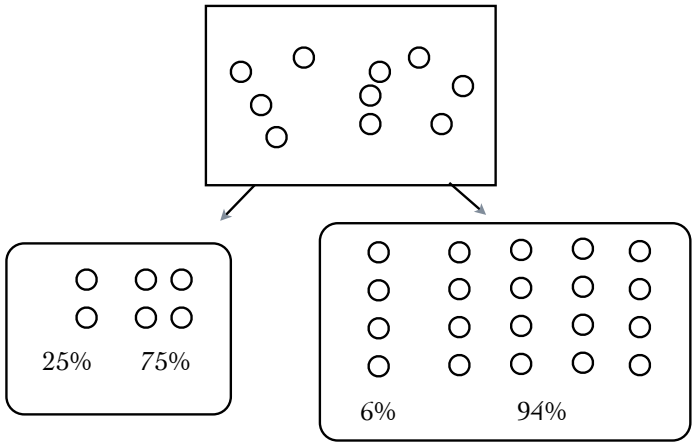
Mutation

Lepus tempermentalis

Process of Natural Selection

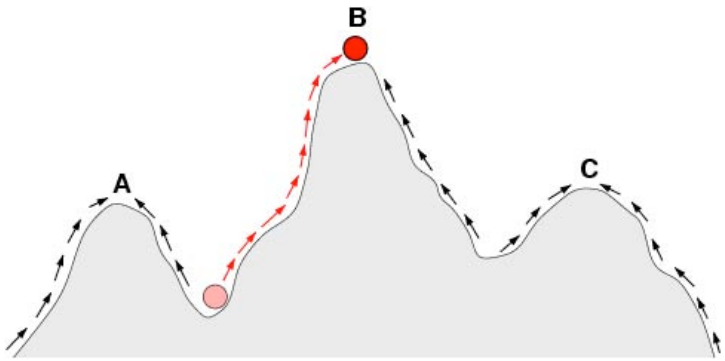


Genetic Drift



random walk simulation

Fitness Landscape
local vs Optimal adaptations



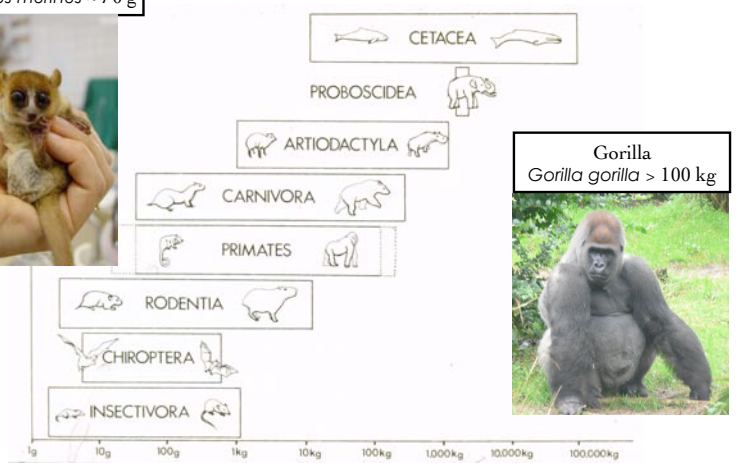
9

Humans are Primates

10

Body Size Diversity

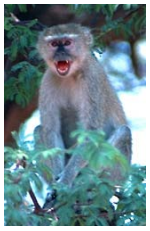
Grey Mouse Lemur
Microcebus murinus ~ 70 g

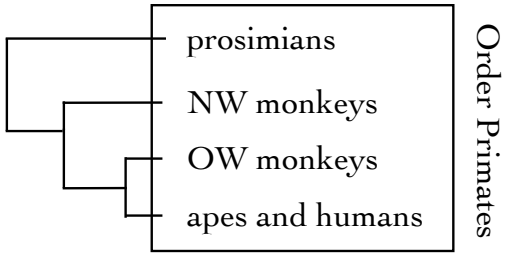


Gorilla
Gorilla gorilla > 100 kg

11

Overview of Primates



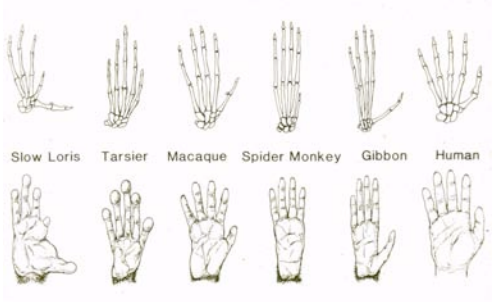


12

Distinguishing Characteristics of Primates

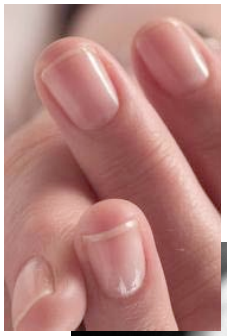
13

Grasping Hands and Feet



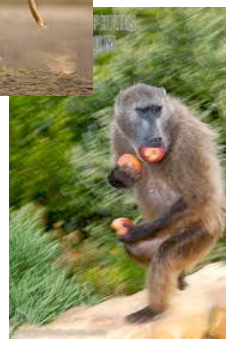
14

Nails not claws



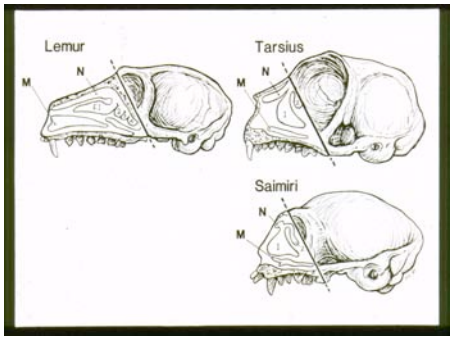
15

Hind Limb Locomotion



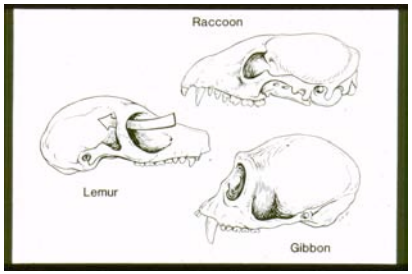
16

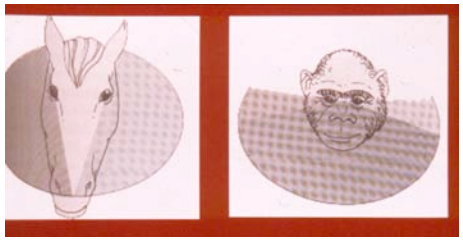
Reduced Olfaction



17

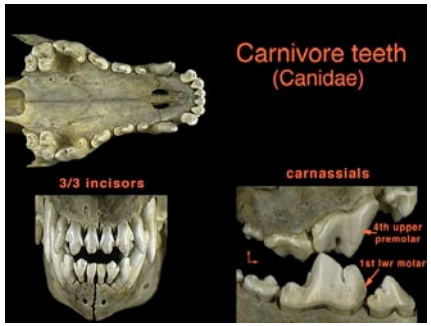
Enhanced Vision

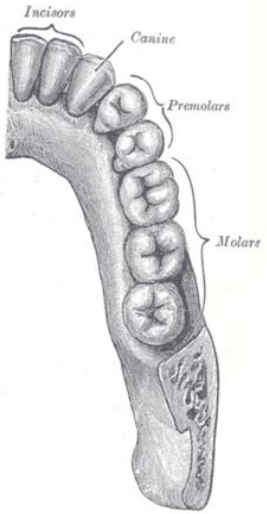




18

Unspecialized molars



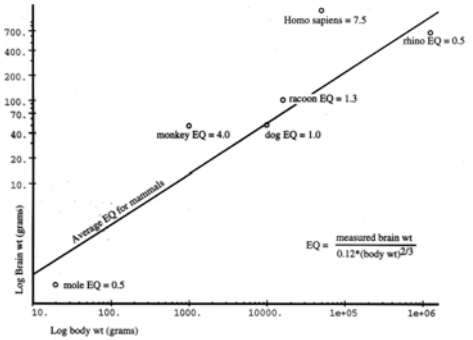


19

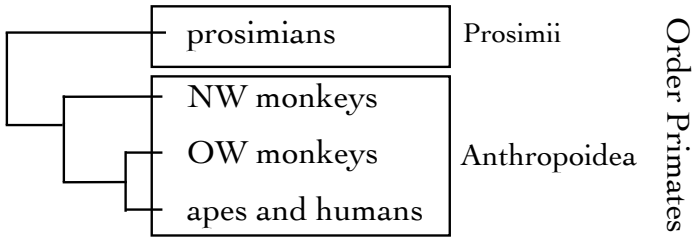
High Parental Investment

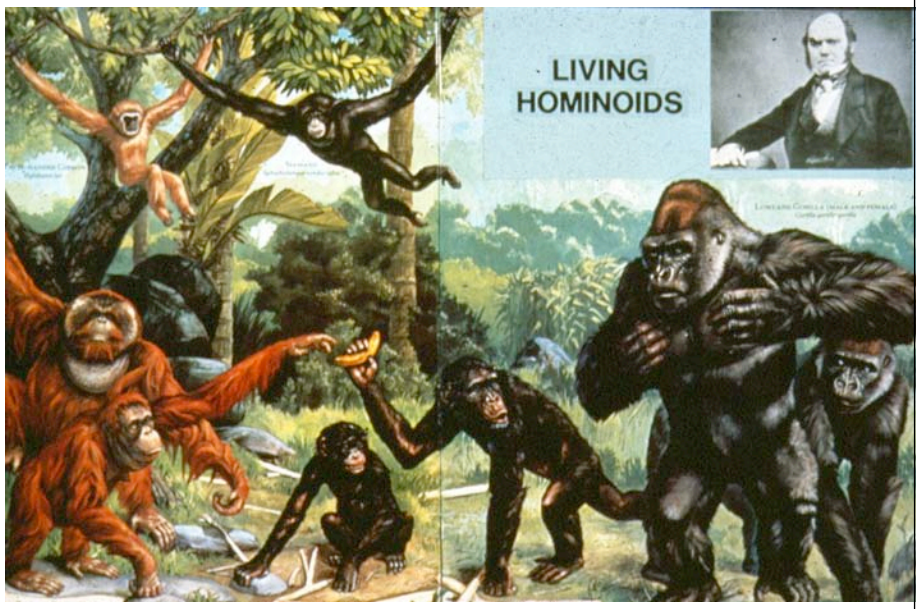
20

Big Brains (encephalization)



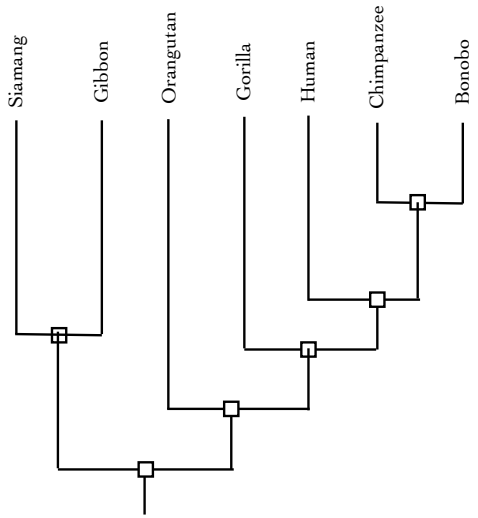
Overview of Primates





23

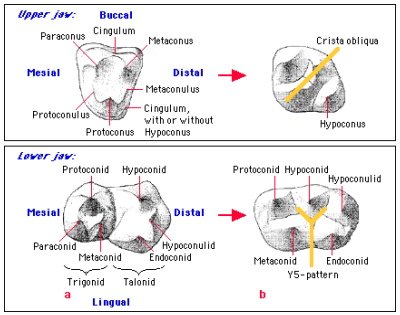
Hominoids



24

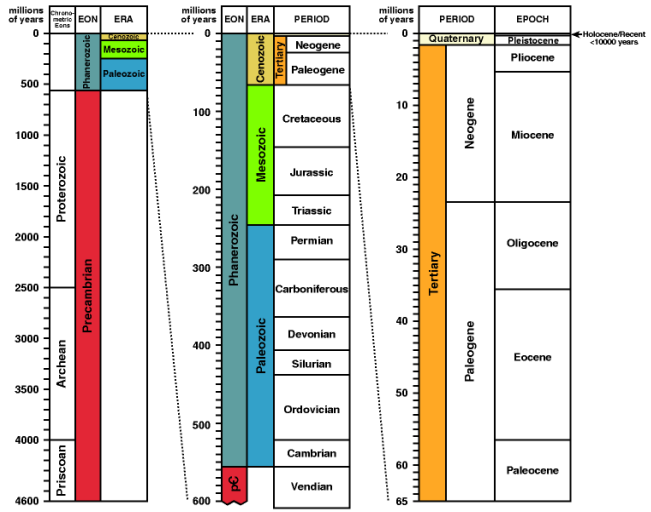
HOMINOID FEATURES

- Distributed through Africa and SE Asia (except humans)
- No tails
- Dental formula 2123
- Y5 cusp pattern on the lower molars
- Sexually dimorphic (except Hylobatidae)



25

GEOLOGICAL TIMESCALE

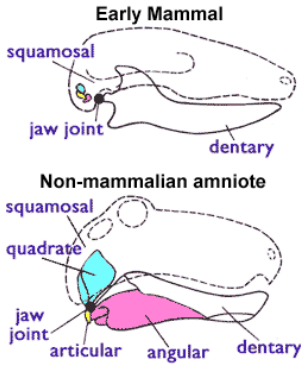


26

Early Mammals

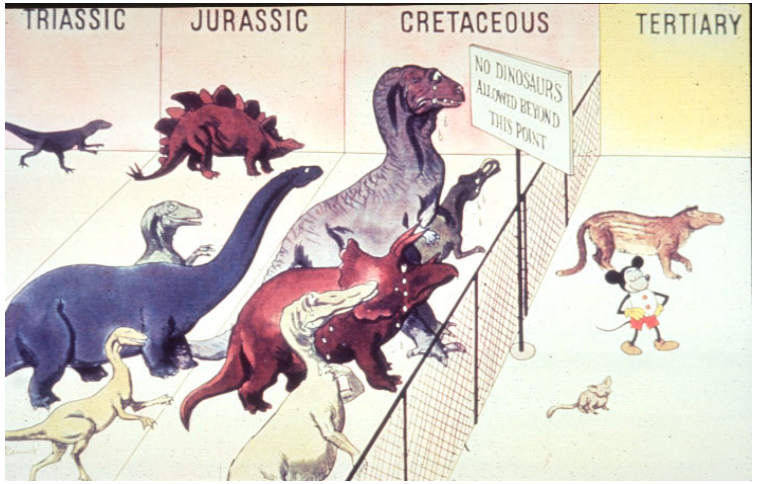
Morganucodon

Balanger's tree-shrew



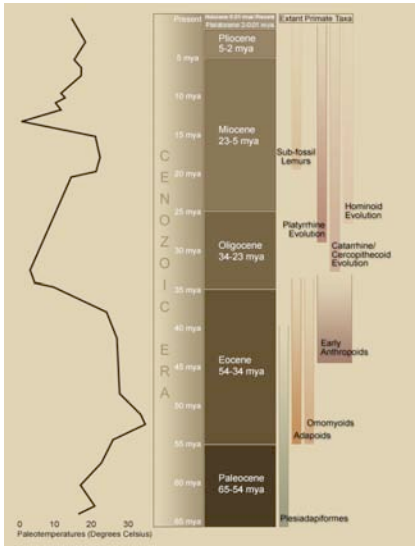
27

Cenezoic Age of Mammals



28

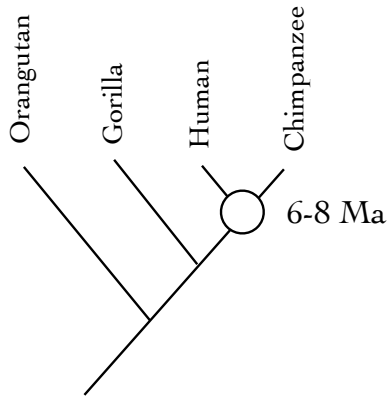
Primates Timeline



29

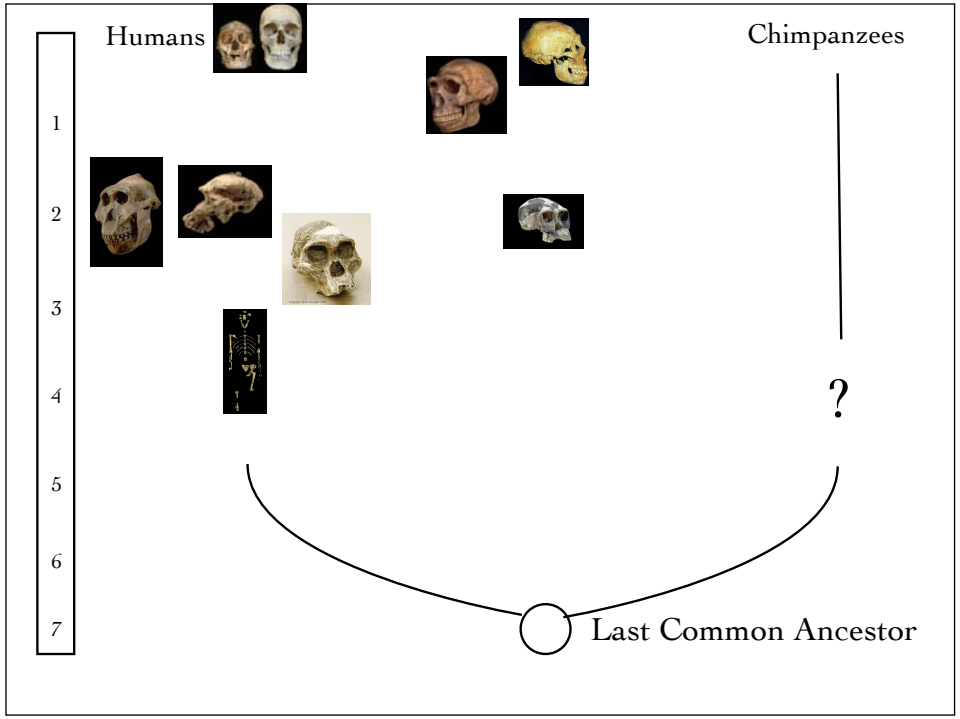
Molecular and anatomical data support a sister group relationship between humans and chimpanzees.

Living Great Apes

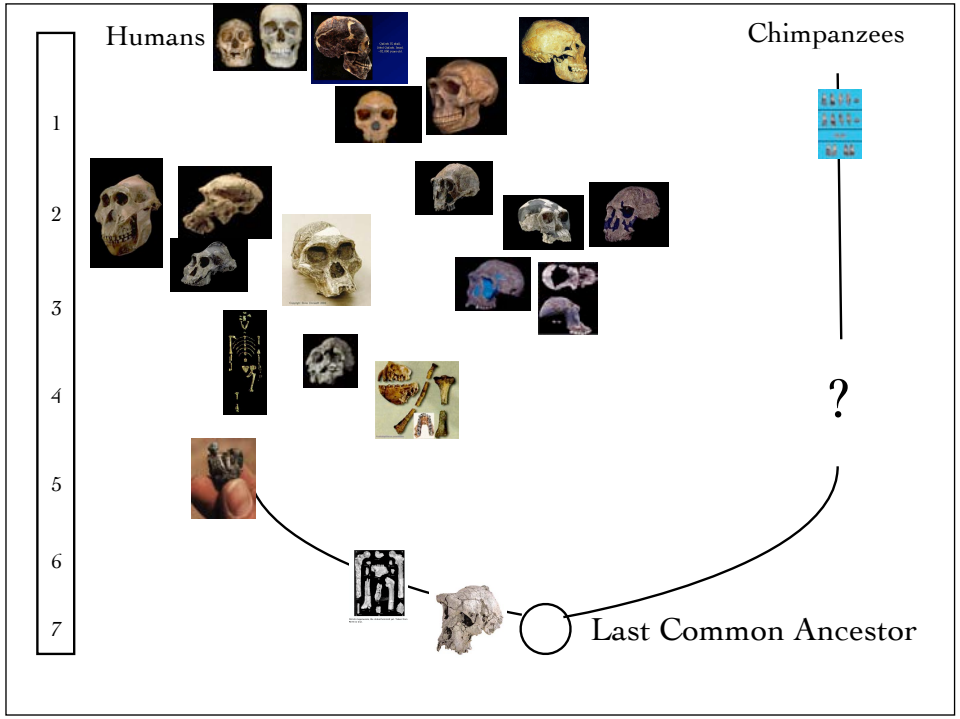


The last common ancestor of chimps and humans lived sometime between 6-8 Ma.

30


Humans
Chimpanzees
1
2
3
4
5
6
7
?
Last Common Ancestor

31


Humans
Chimpanzees
1
2
3
4
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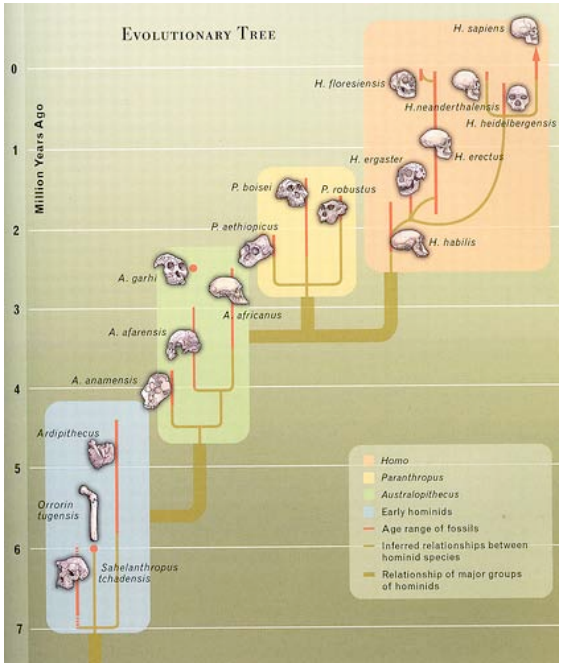
7
?
Last Common Ancestor

32



33

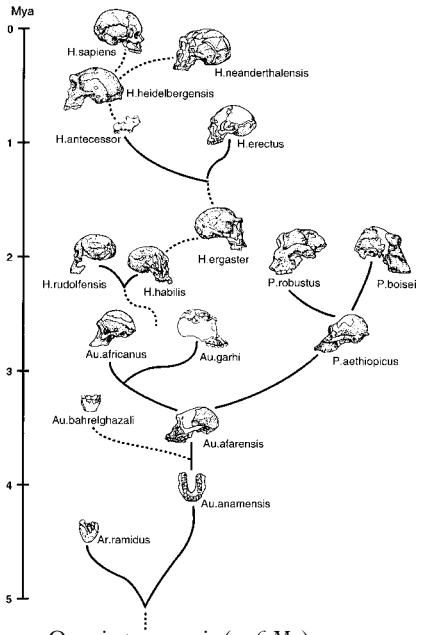
Hominin Adaptations

Scavenging/Hunting

Tool Use

Megadonty

Bipedality



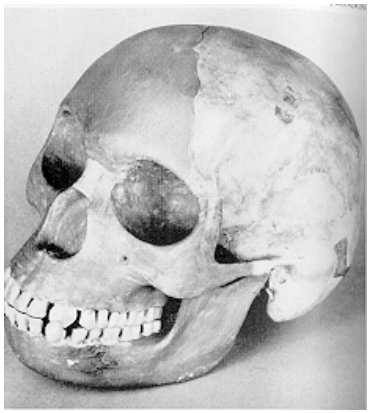
Orrorin tugenensis (ca 6 Ma)

Sahelanthropus tchadensis (ca 7 Ma)

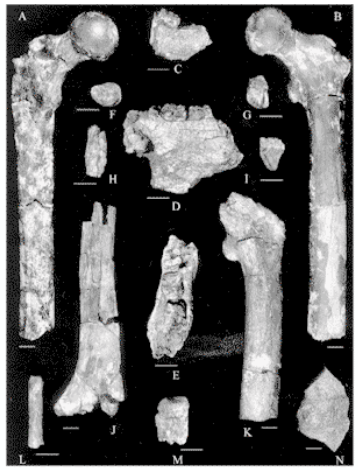
34

Piltdown Man HOAX

- "discovered" in 1912 in Sussex England's Piltdown Quarry
- Large brain with hominoid (Orangutan mandible)
- Fit the expectation of a large brain matched with primitive teeth and jaw

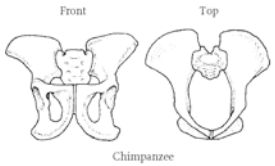


Earliest Hominins



Orrorin tugenensis, the oldest hominid yet. Taken from Ref 8 in text.

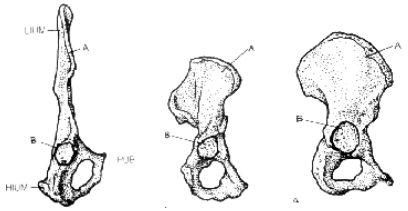
Bipedalism



Pan

Austral.

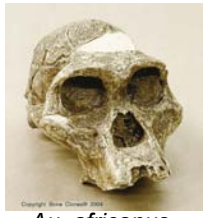
Homo



Pan Austral. Homo

37

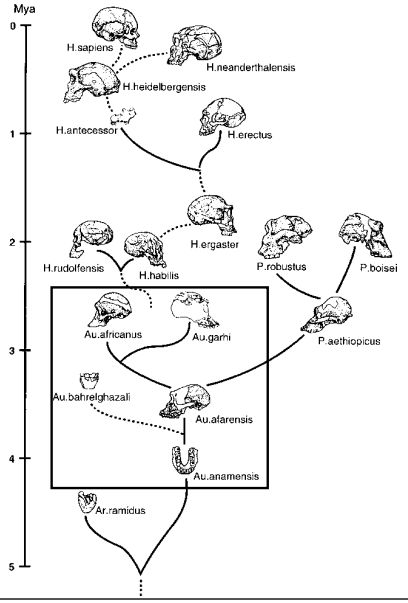
Australopithecus



Au. africanus

Au. afarensis

Au. anamensis



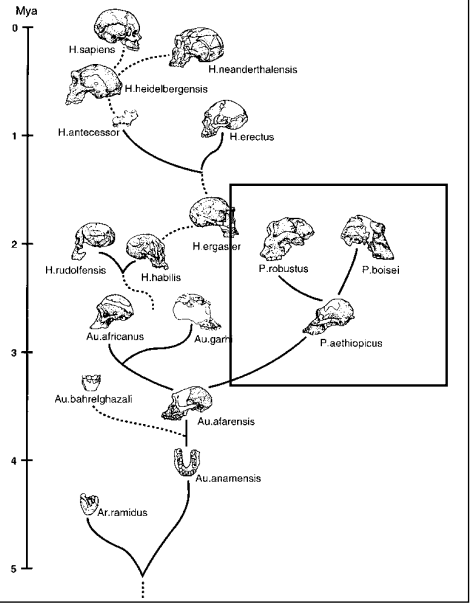
38

Paranthropus

P. boisei

P. robustus

P. aethiopicus



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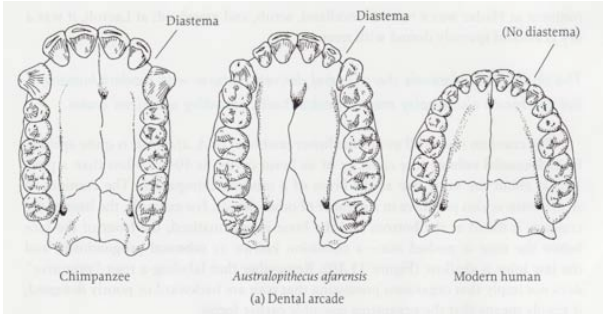
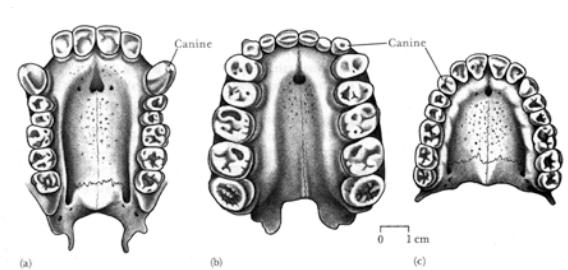
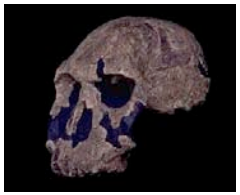




40

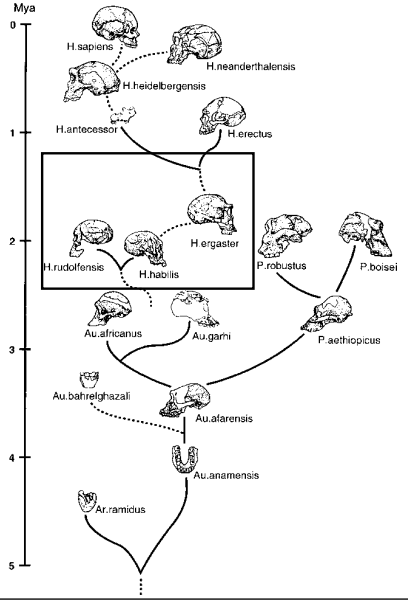
Early Homo

H. ergaster



H. rudolfensis

H. habilis



41

Lithics

Olduwan tools (Mode 1)

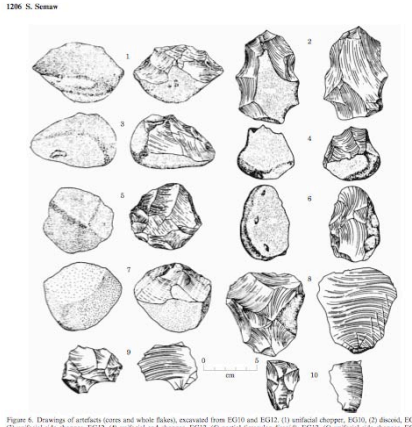


Figure 6. Drawings of artefacts (cores and whole flakes), excavated from EG10 and EG12. (1) unifacial chopper, EG10, (2) discoid, EG10, (3) unifacial side chopper, EG12, (4) unifacial end chopper, EG12, (5) partial (irregular discoid), EG12, (6) unifacial side chopper, EG10, (7) unifacial side chopper, EG12, (8–10) whole flakes, EG10.

Acheulean tools (Mode 2)

53.—Lower Acheulean implements from St. Acheul 1. A typical boucher; 2. an "amande" or ovate boucher; 3. a scraper. (After Commont, *L'Anthropologie.* × ½.)

42

Expensive Tissue Hypothesis

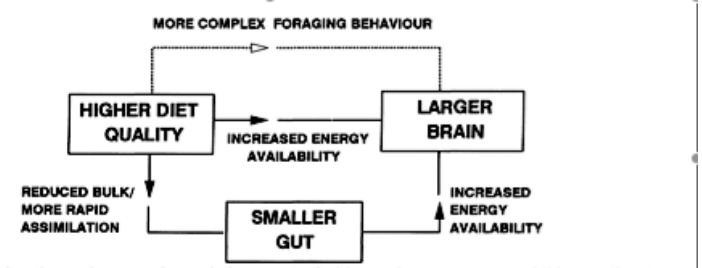
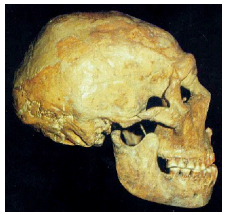


FIG. 5. *High-quality diet and increased encephalization.* Dashed line, *selection pressure;* solid lines, *relaxed constraints.*

43

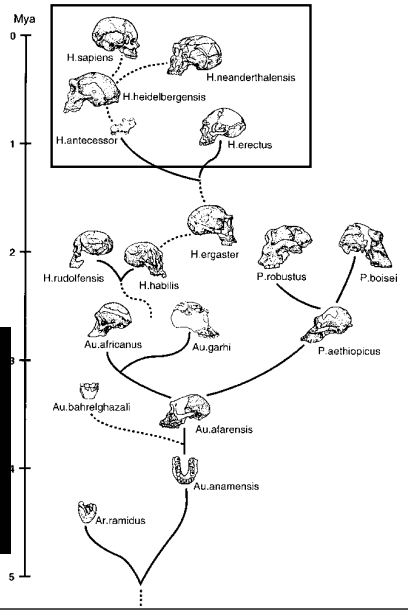
Later Homo

H. heidelbergensis



Neanderthals

H. erectus

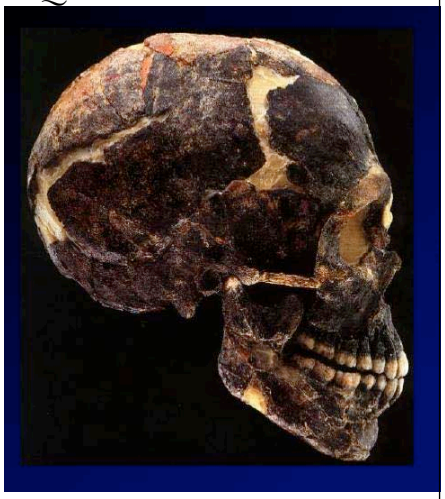


44

Features of AMHS

Shanidar, neanderthal

Qafzeh IX AMHS

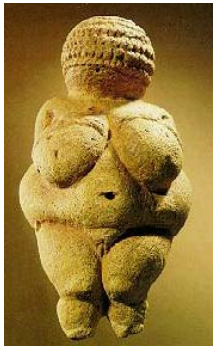


45

Upper Paleolithic

46

Upper Paleolithic Art



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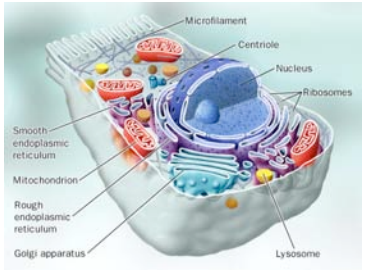
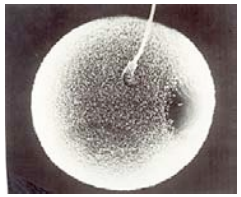
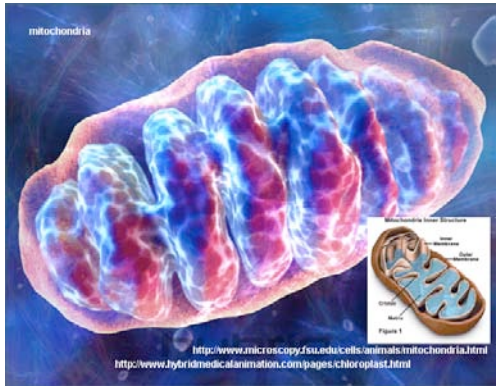
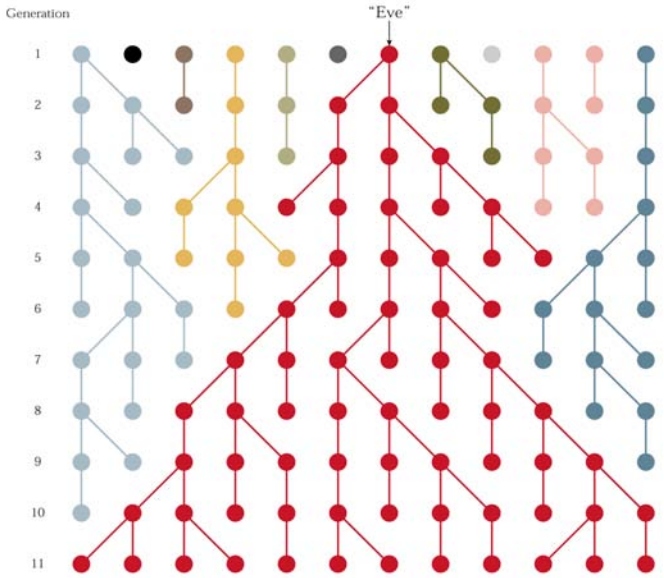
Neanderthal mtDNA

Mitochondrial DNA



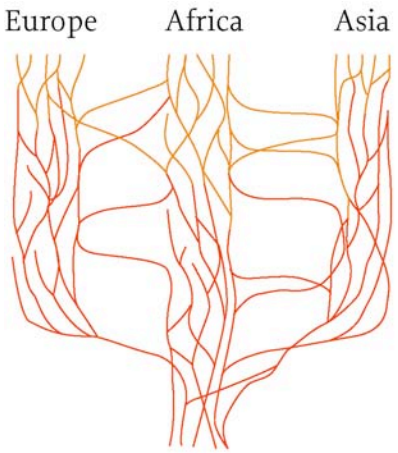






Genetic Diversity

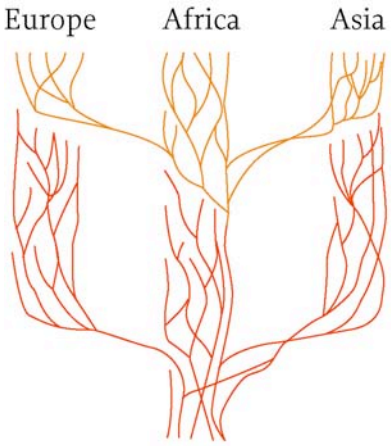
- Human populations have low genetic variability (e.g. as compared to Chimpanzees)
- The greatest genetic diversity is in Africa



Multiregional model

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

H. erectus disperses from Africa.

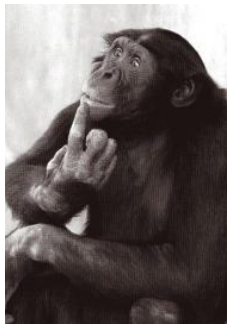


Anatomically modern *H. sapiens* evolves in Africa and then spreads to Europe and Asia.

H. erectus disperses from Africa.

Out of Africa model

Primate Life History and Intelligence



Life History Trade-Offs

r selected species

precocial
reproduce earlier
smaller body size
smaller brains
shorter gestation
larger litters
higher mortality rates
shorter life spans

K selected species

altricial
reproduce later
large body size
larger brains
longer gestation
smaller litters
lower mortality rates
longer life spans

55

What Monkeys Know

- Detailed knowledge of edible plants and their distribution.
- Mental mapping
- Unique predator identification
- Social Knowledge

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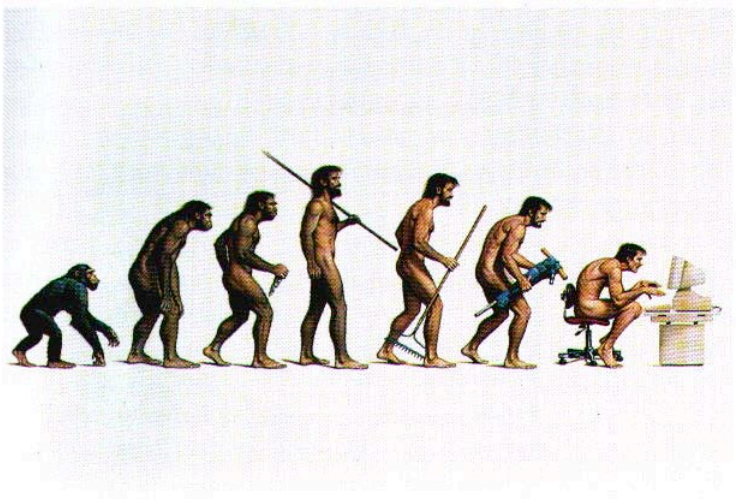
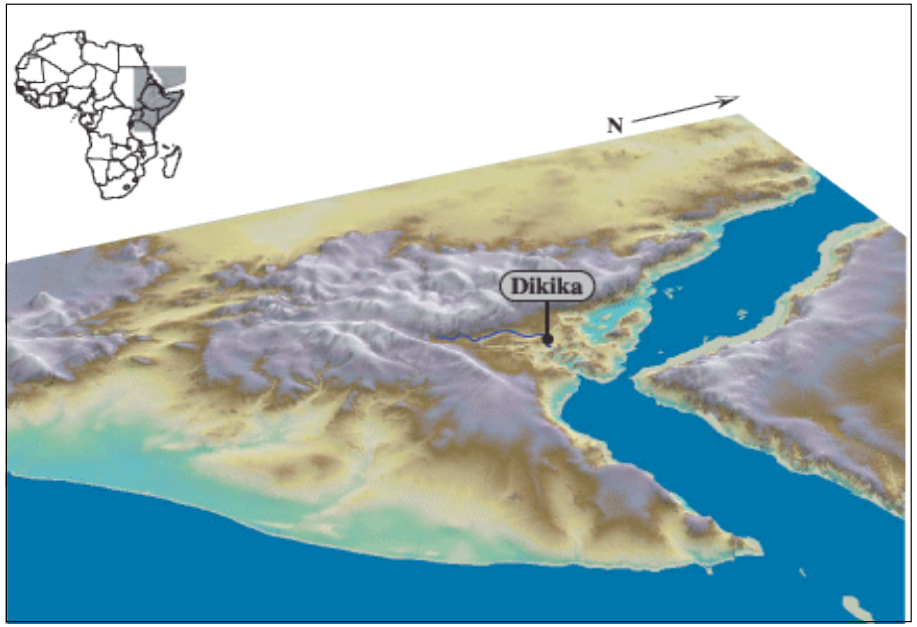
Devolution





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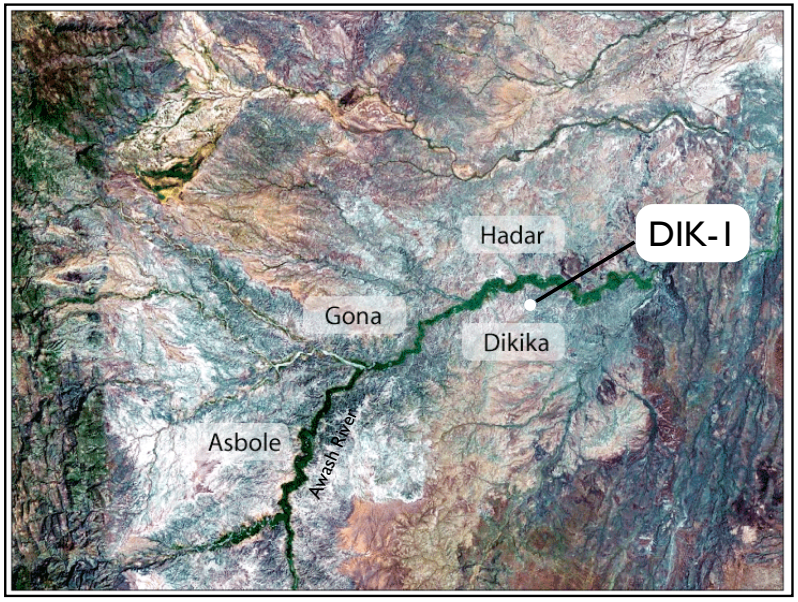

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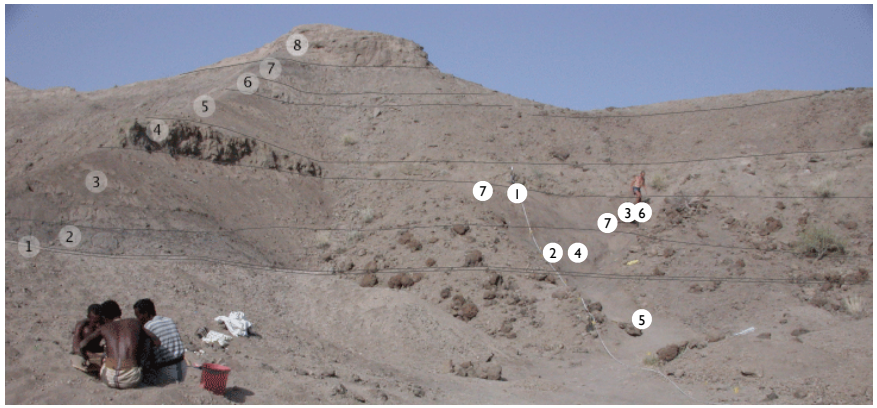

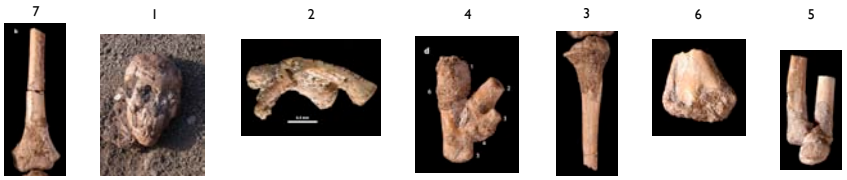

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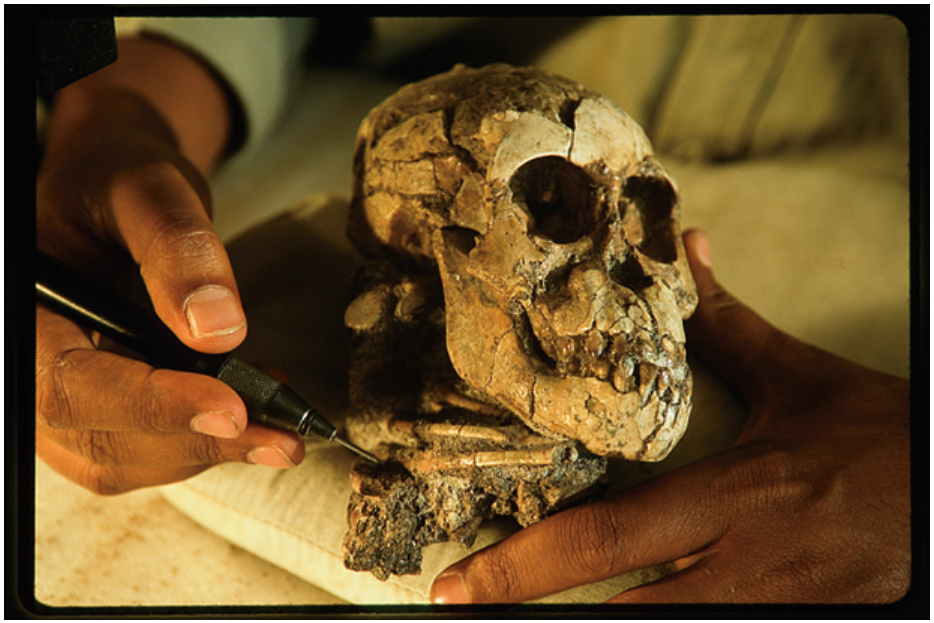

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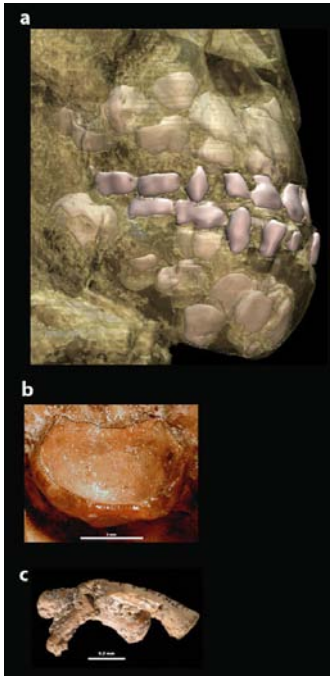
"Selam"

68



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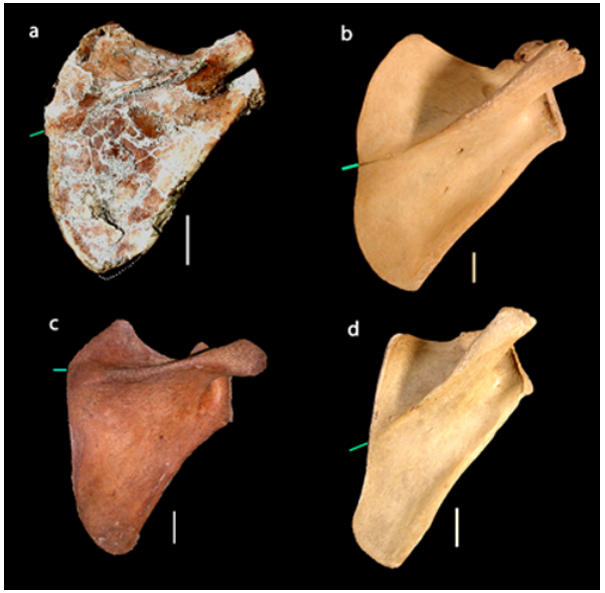

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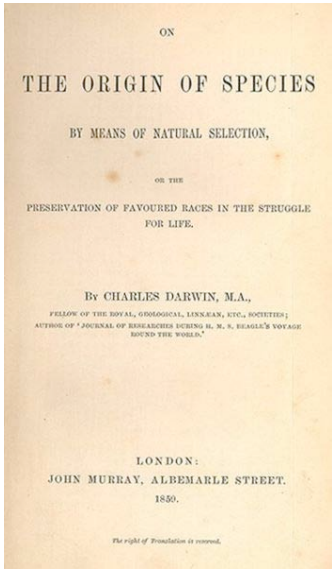
"light would be
thrown on the origin of man
and his history"



ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A.,

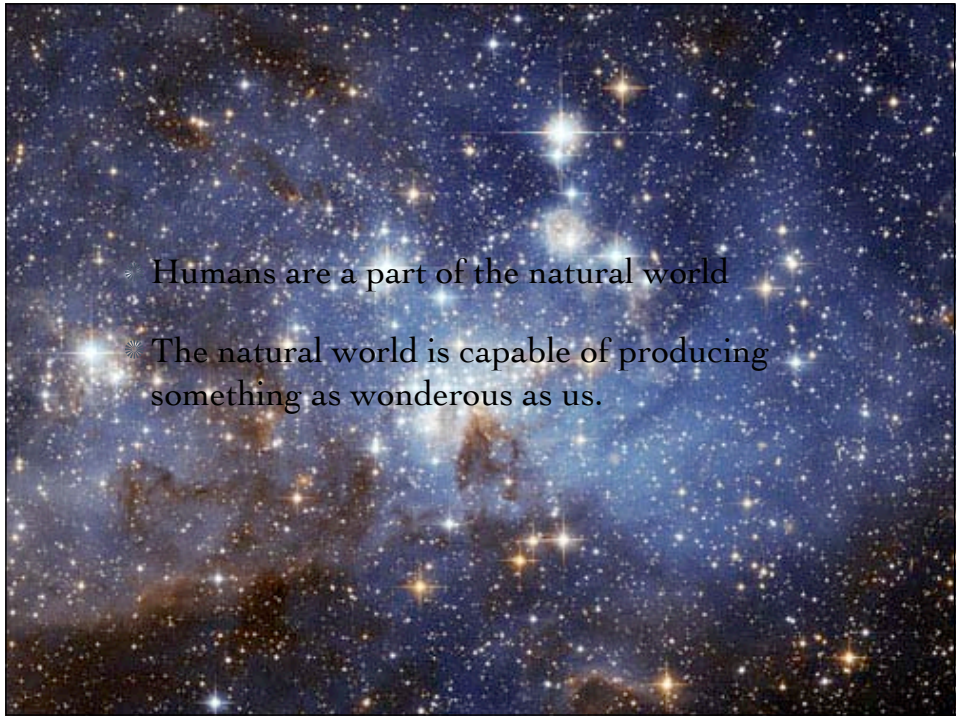
FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

88

Australopithecus afarensis

89



90

- Humans are a part of the natural world
- The natural world is capable of producing something as wonderous as us.

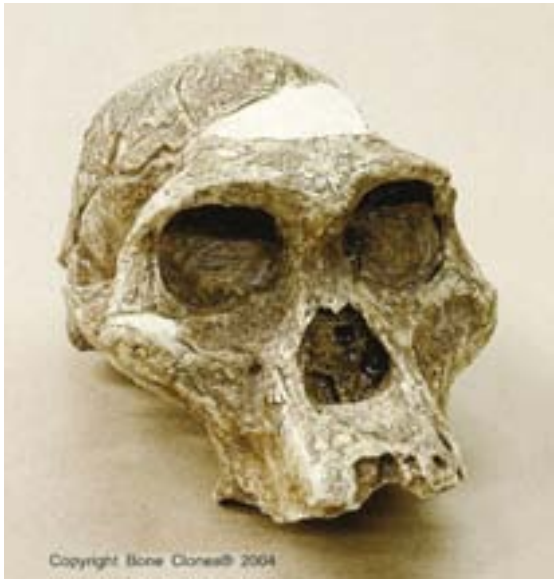
Upper Paleolithic Revolution

Cro Magnon

Mechanics of Bipedalism

adducted big toe

93



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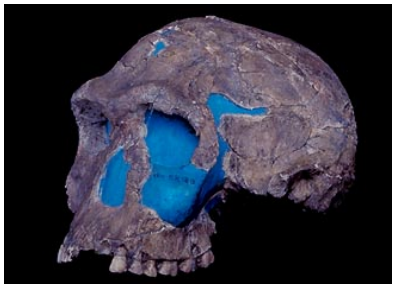
Homo habilis

OH 24



KNM ER 1813

Homo ergaster

East Lake Turkana

- Cranial capacity ca 800 cc
- Thick cranial vault
- Moderate brow ridge
- Olduwan lithics

Homo ergaster

Homo ergaster from Dminisi Georgia, 1.8 Ma

97

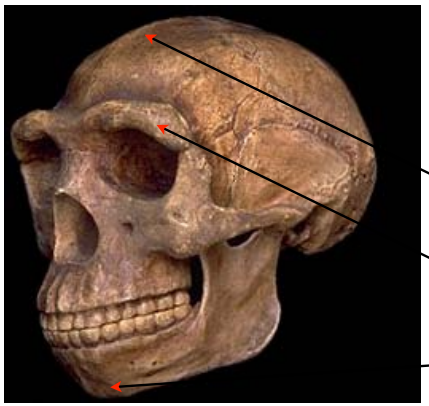
Atapuerca

Atapuerca 5

98

99

Asian Homo erectus



- Cranial capacity ca 900 cc
- Thick cranial vault
- Sagittal keel
- Heavy brow ridge
- No chin

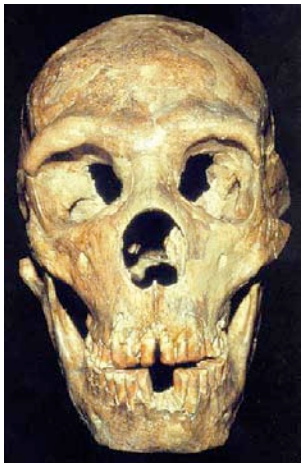
Zhoukoudian

100

East Asian Homo heidelbergensis

Dali ca 200 Ka China

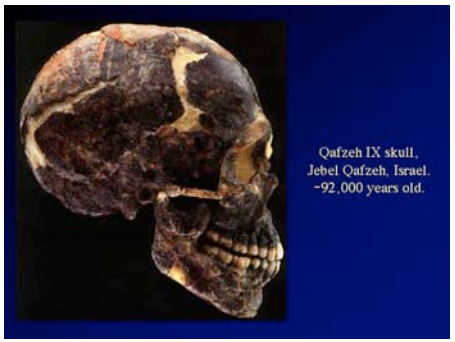
Neanderthal Characteristics



Homo floresiensis

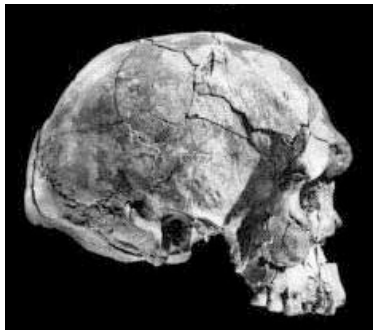
Levantine Fossils

Amud



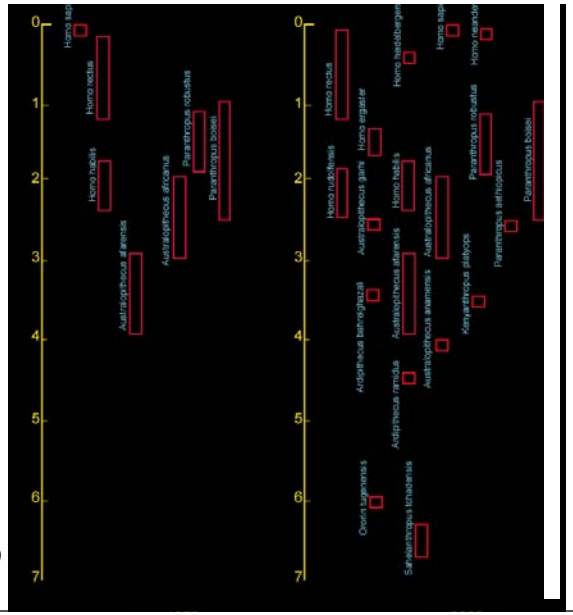
Qafzeh 9

Earliest AMHS



Herto

Hominin Diversity



ca 1979 2008

Sahelanthropus tchadensis

- ca 7 Ma
- Koro Toro Site in Chad

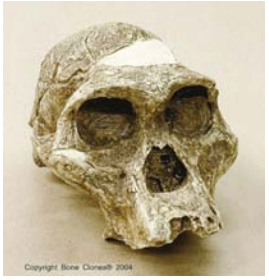
Orrorin tugenensis

Orrorin tugenensis, the oldest hominid yet. Taken from Ref 8 in text.

- ca 6 Ma
- Tugen Hills Kenya

Australpithecines

- *Australopithecus:*
  - *A. anamensis*
  - *A. afarensis*
  - *A. africanus*
  - *A. garhi*
- *Paranthropus:*
  - *P. aethiopicus*
  - *P. robustus*
  - *P. boisei*
- *Kenyanthropus platyops*



The Theory of Evolution

The process of evolution as seen in:

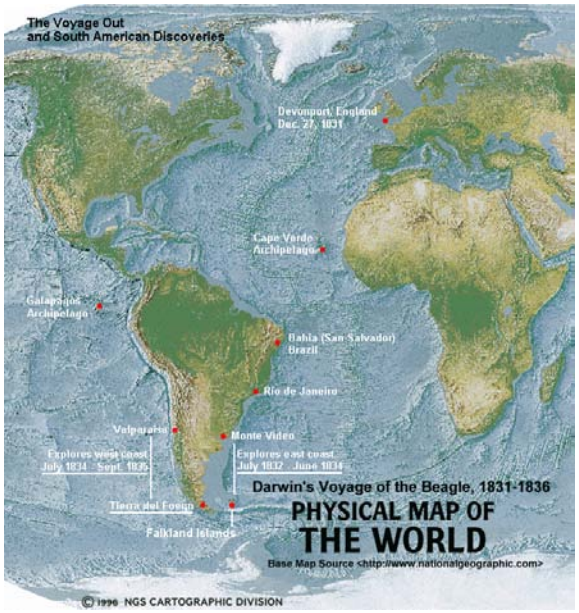
1. The fossil record
2. Biogeography
3. Genetics
4. Developmental Biology
5. Comparative Anatomy

all support the *theory* of evolution by natural selection along with other evolutionary mechanisms such as genetic drift.

What Monkeys Know

- Unique predator identification.
- Third-party relationships
- Kinship relationships
- Dominance hierarchies

111



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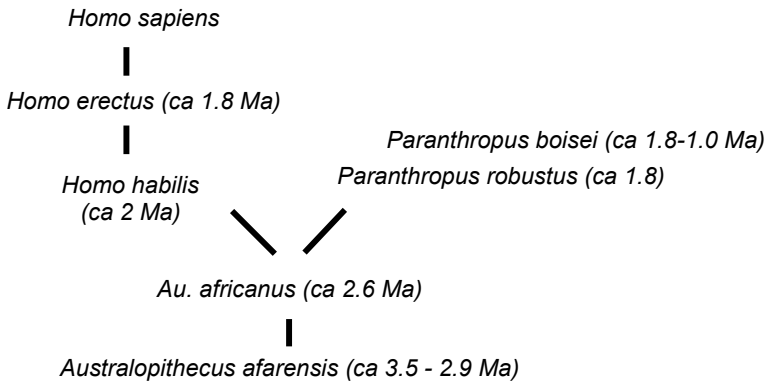
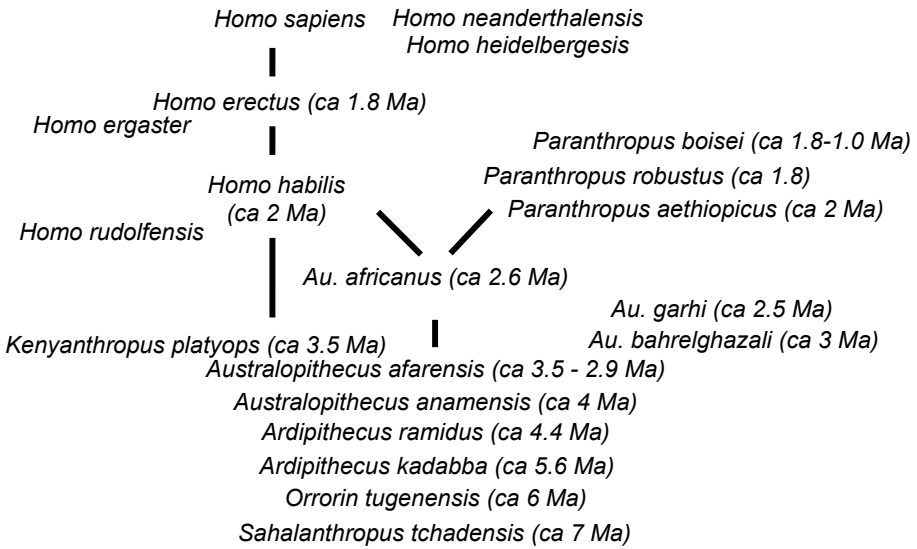
Reciprocal Altruism

- frequent interaction
- record keeping
- limit support to reciprocators

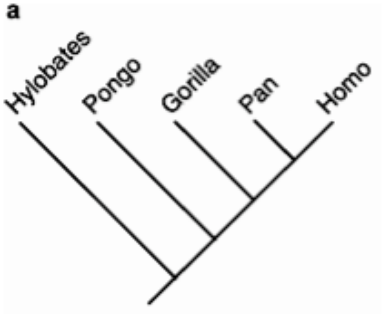
Simple Phylogeny



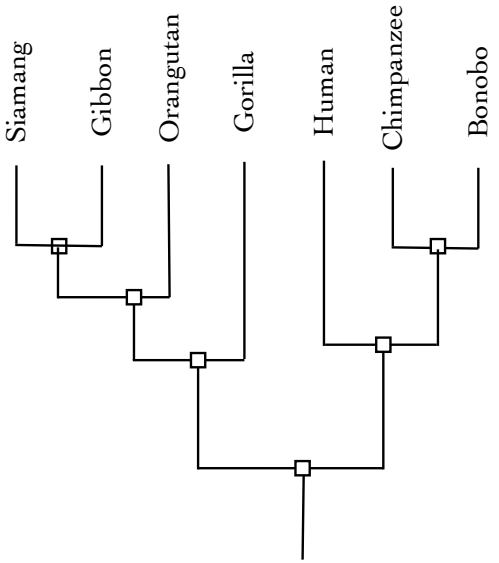
(not so) Simple Phylogeny



Hominoid Phylogeny



Molecular data
(DNA sequence and DNA-DNA hybridization)
consistently point to a Pan as the sister group to Homo


Siamang
Gibbon
Orangutan
Gorilla
Human
Chimpanzee
Bonobo

117

118

Nicholas Steno
1638 - 1686

- Anatomist who worked for the Grand Duke of Tuscany, Ferdinand II
- Principle of original horizontality and superposition

Alfred Russel Wallace
1823 - 1913

Co-Discoverer of Natural Selection

Brain Size

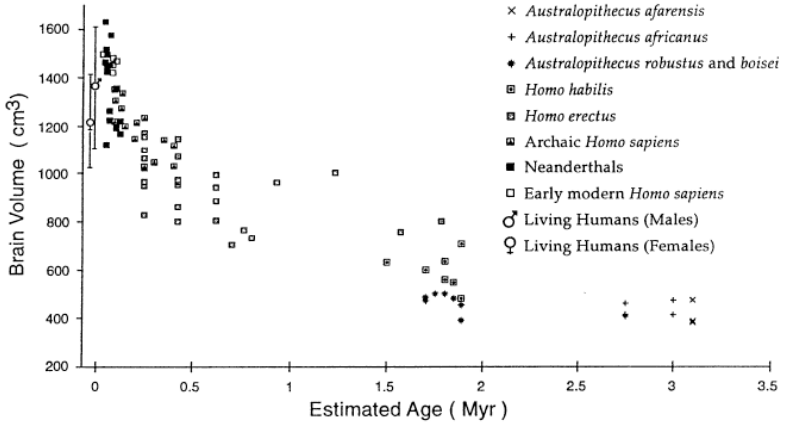


FIG. 4. Brain size (in cm^3) plotted against time (Myr) for specimens attributed to Hominidae.

Australopithecus africanus

- South Africa (Taung, Sterkfontein and others)
- ca 3 to 2.2 Ma

Taung

P. robustus

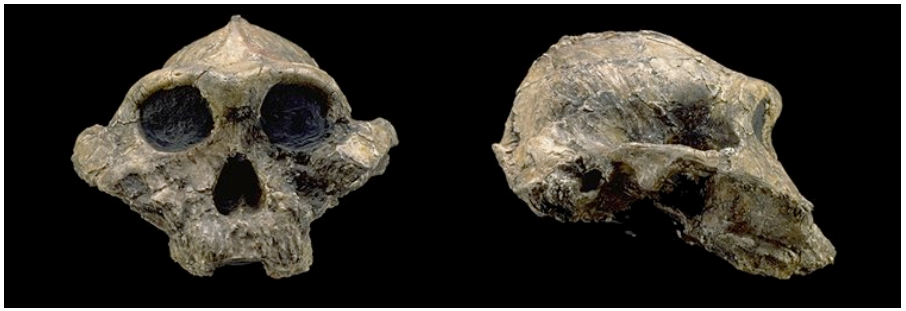
SK 46

123

OH 5 "Zinj"
Paranthropus boisei

124

P. robustus



KNM ER 406

125

P. robustus

126

Comparision

Au. afarensis Au. aethiopicus Au. boisei

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Strapping Youth

12 year-old male
1.6 m tall (5 ft. 4 in)
adult stature approx. 1.9 m (6 ft.)

128

Strapping Youth

12 year-old male
1.6 m tall (5 ft. 4 in)
adult stature approx. 1.9 m (6 ft.)

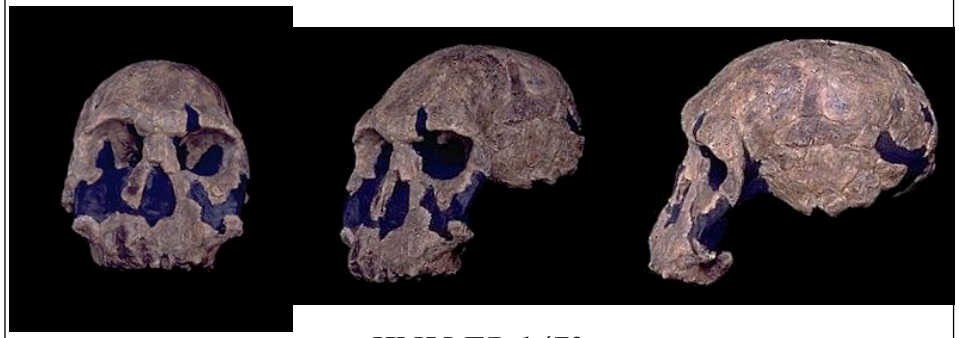
129

Homo ergaster

East Lake Turkana

130

Homo rudolfensis

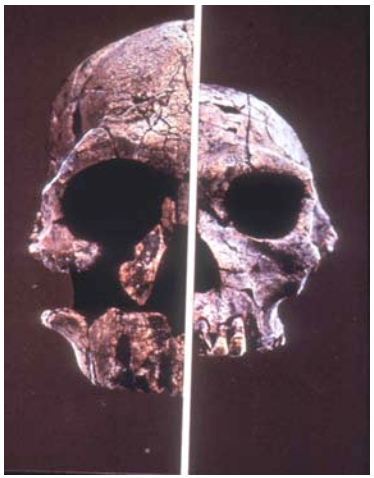


KNM ER 1470

131

How Many Species?

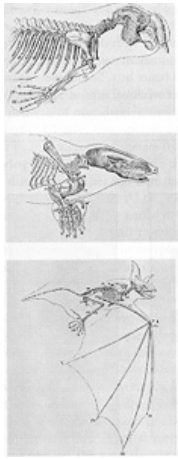
KNM ER 1470
Homo rudolfensis

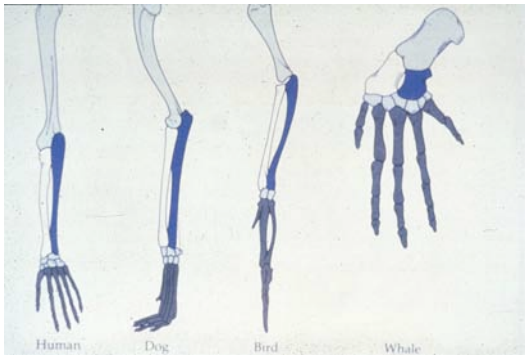


KNM ER 1813
Homo habilis

132

Homologous Structures





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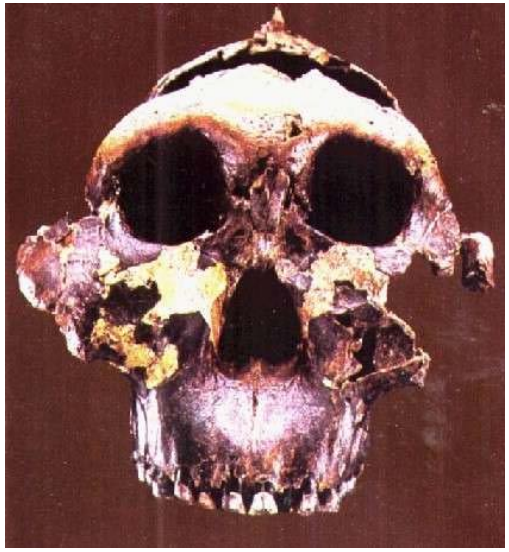

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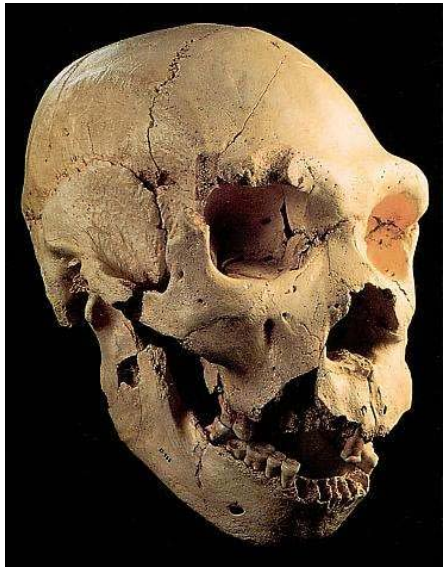

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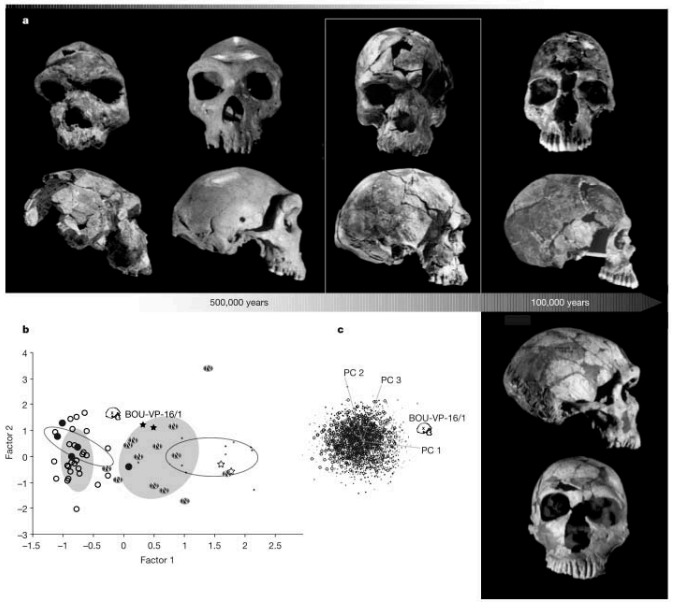

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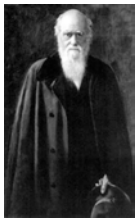
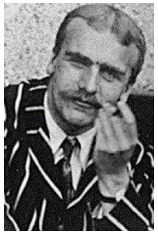
Modern Synthesis





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Evolutionary rates