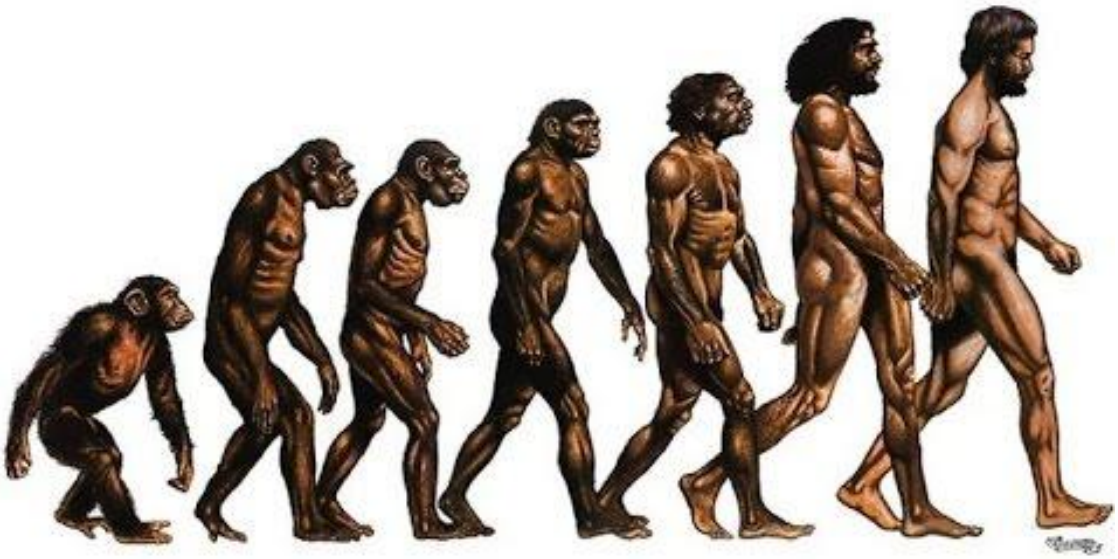
# G11.4B – Evolution – Anthropogensis

CIE Biology Jones



TWIG – Chimps our closest relative? 2.43 min
https://twig-bilim.kz/film/chimps-our-closest-relatives-1131/

15 Tweaks that made us human
http://www.bbc.com/earth/bespoke/story/20150311-the-15-tweaks-that-made-us-human/index.html

Understanding Evolution Website
https://evolution.berkeley.edu/evolibrary/article/evo_14

## Learning Objectives

11.2.6.2 Describe the stages of anthropogenesis

http://humanorigins.si.edu/resear

## Success Criteria

1. Describe the stages of anthropogenesis using at least one example for each of the stages.
2. Compare brain size, diet, and other items for each stage.

# Research Criteria -Anthropogenesis

1. Your group is assigned one Hominid to research.
2. Create an poster with the main criteria
3. Create a stick figure with the head attached. (height)
4.

Smithsonian http://humanorigins.si.edu/research

-timeline and other

Handprint https://www.handprint.com/LS/ANC/evol.html

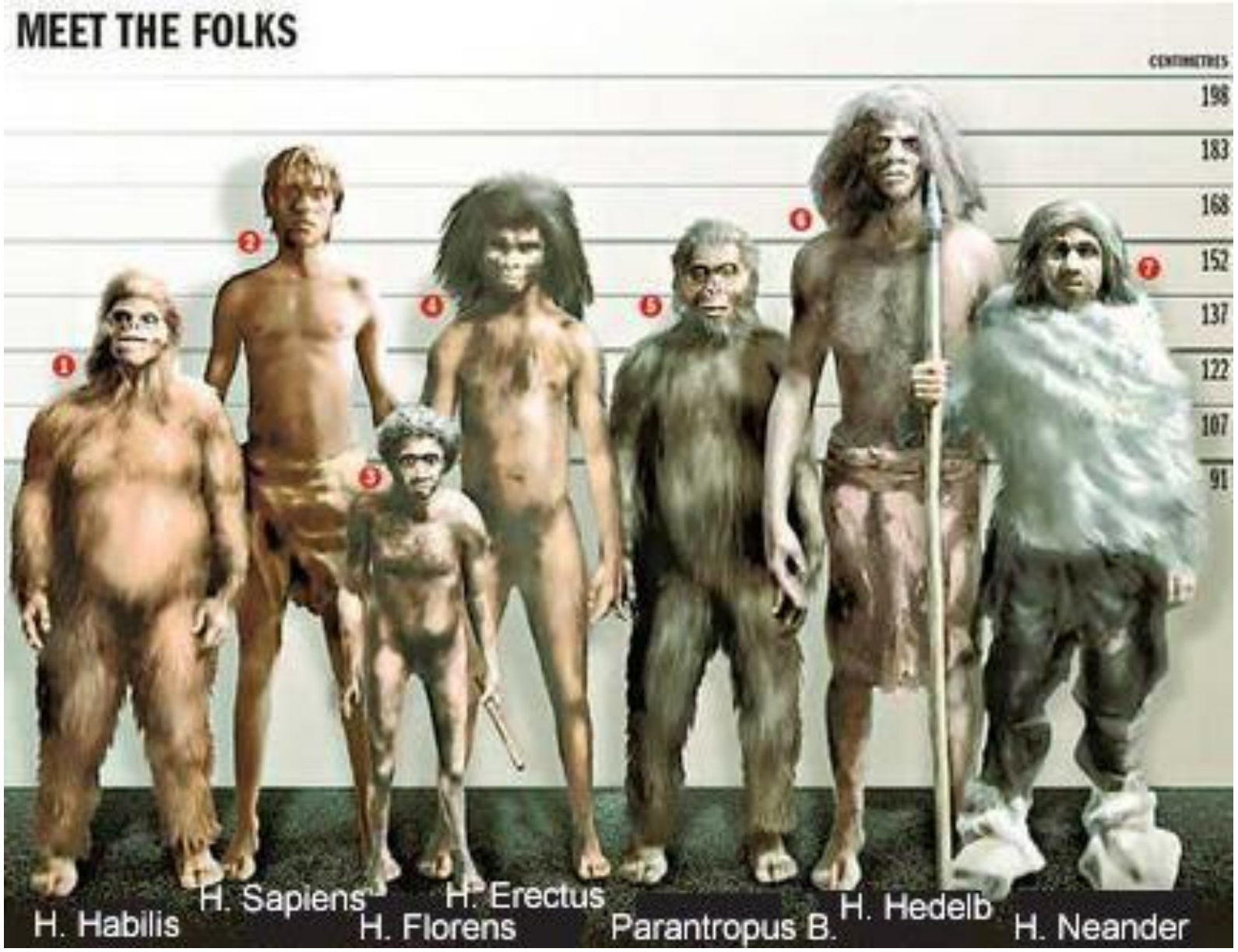
Human Evolution Timeline – determine

a. Did they co-exist with any of the other hominds?
b. Time range when they existed.
c. Essay - Compare

| | Australopithecus | Homo habilis | Homo erectus | Homo neanderthalensis | Homo sapiens |
|---|---|---|---|---|---|
| Time period | | | | | |
| Brain size ($cm^3$) | | | | | |
| Diet | | | | | |
| Cultural | | | | | |
| Anatomical | | | | | |
| Locomotion | | | | | |

# Vocabulary: Anthropogenesis

| English | Google Russian ☺️ |
| --- | --- |
| Prehensile | цепкий |
| Stereoscopic vision | стереоскопическое восприятие |
| Unspecialized digestive system | Неспециализированная пищеварительной системы |
| Social grouping | Социальная группировка |
| Primate | примат |
| Promisians | полуобезьян |
| Anthropoids | антропоидов |
| Hierarchy | иерархия |
| Opposable thumb | противопоставленным большим пальцем |
| Arboreal | древесный |


MEET THE FOLKS
CENTIMETRES
198
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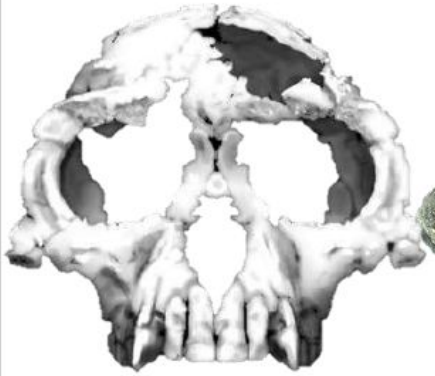
H. Habilis
H. Sapiens
H. Florens
H. Erectus
Parantropus B.
H. Hedelb
H. Neander



*Ardipithecus ramidus*

*Australopithecus afarensis*

*Australopithecus africanus*

http://commons.wikimedia.
http://commons.wikimedia.
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http://www.flickr.com/phot

Skulls not to scale

*Homo habilis*

*Homo erectus*

*Homo neanderthalensis*

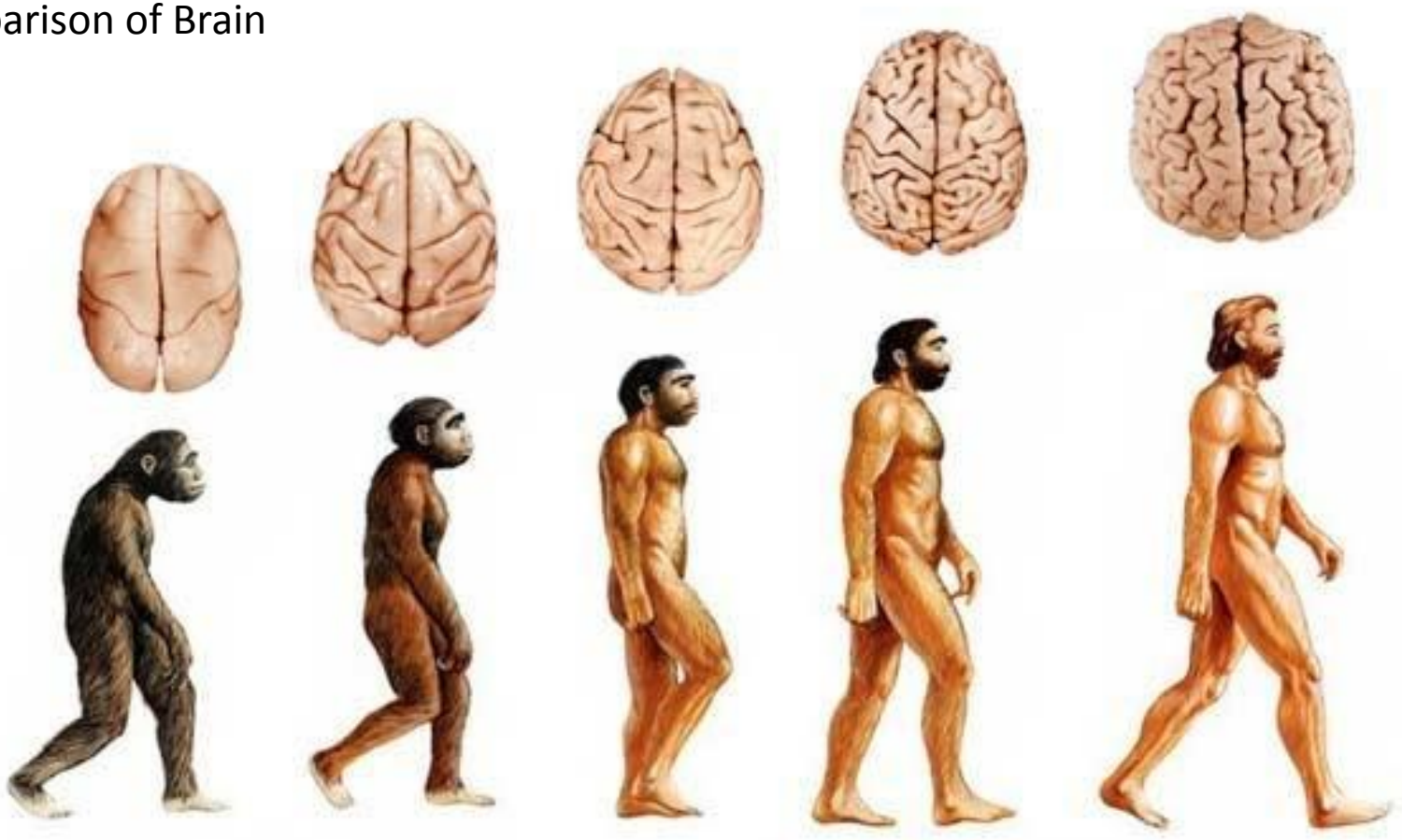
*Homo sapiens*

From the previous two slides you can see:

- enlargement of the brain case
- shortening of the face
- loss of brow ridges

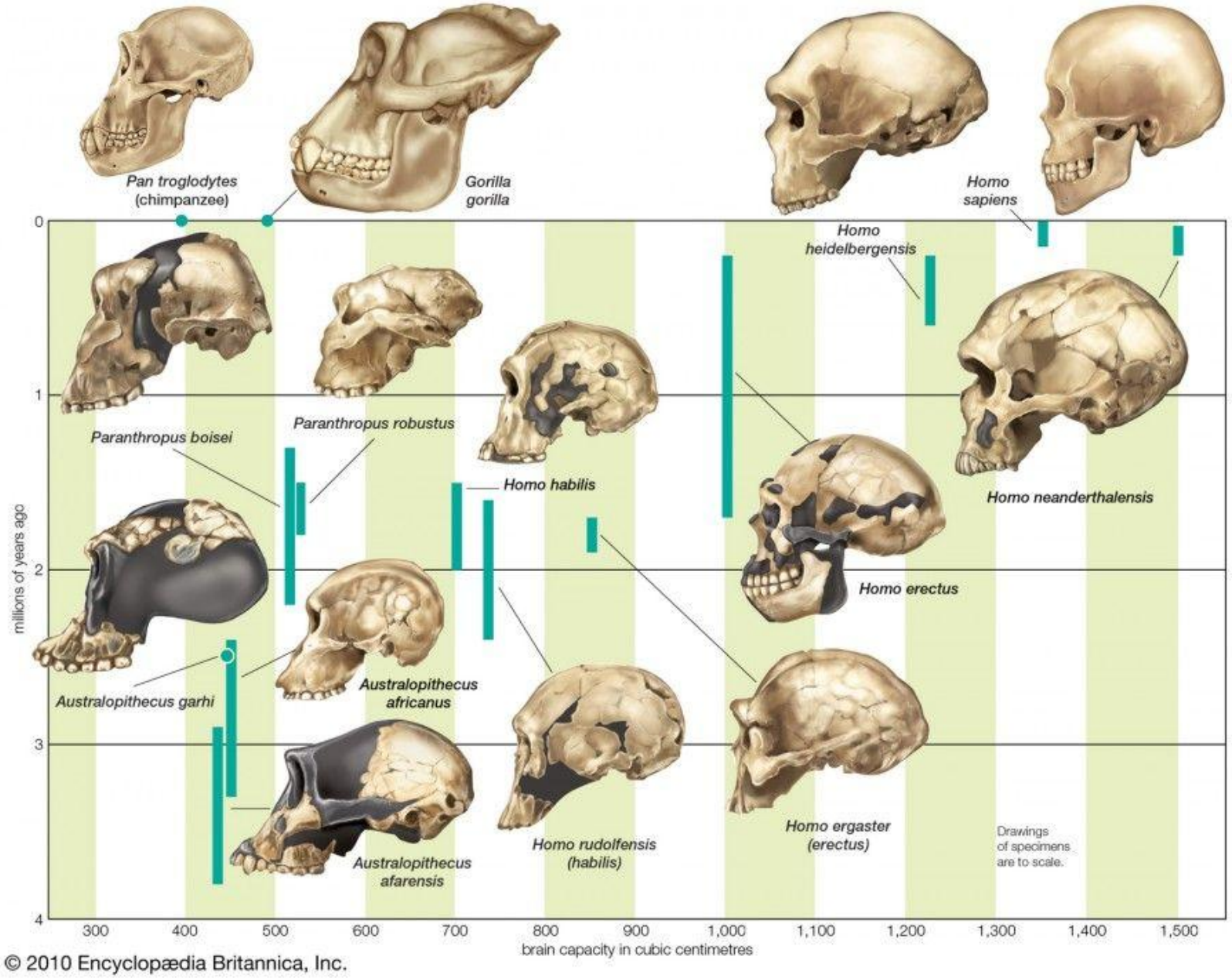
You can't really see it but the hole in the bottom of the skull where the spinal cord exits the brain (foramen magnum) is further forward in modern humans. This distributes the weight of the head over the spine so that modern humans do not need huge necks muscles.

Comparison of Brain

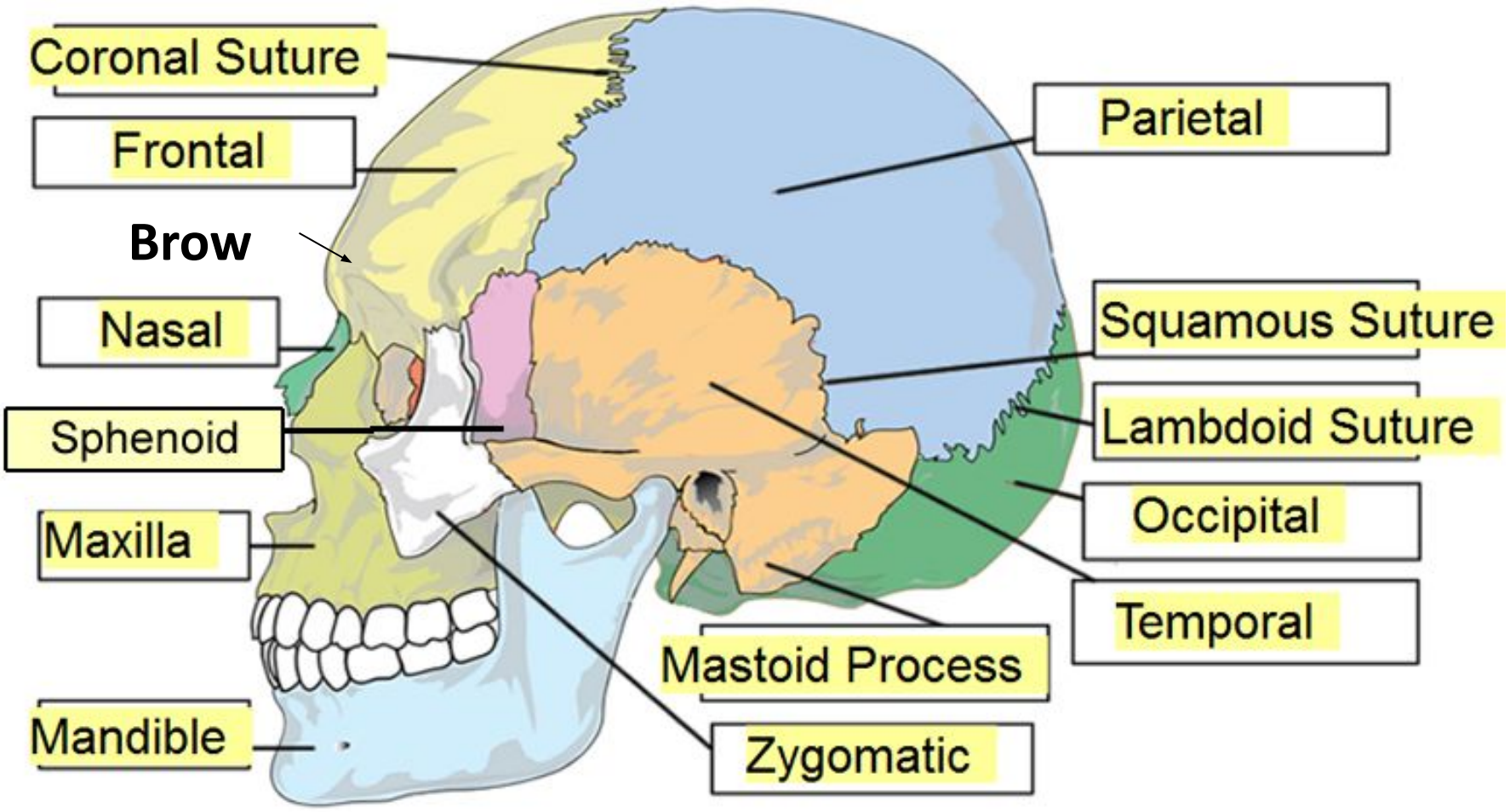


*Australopithecus* *H. hablis* *H. ecrectus* *H. neanderthalensis* *H. sapiens*

# Evidence: Brain Capacity in cubic centimeters ($cm^3$)

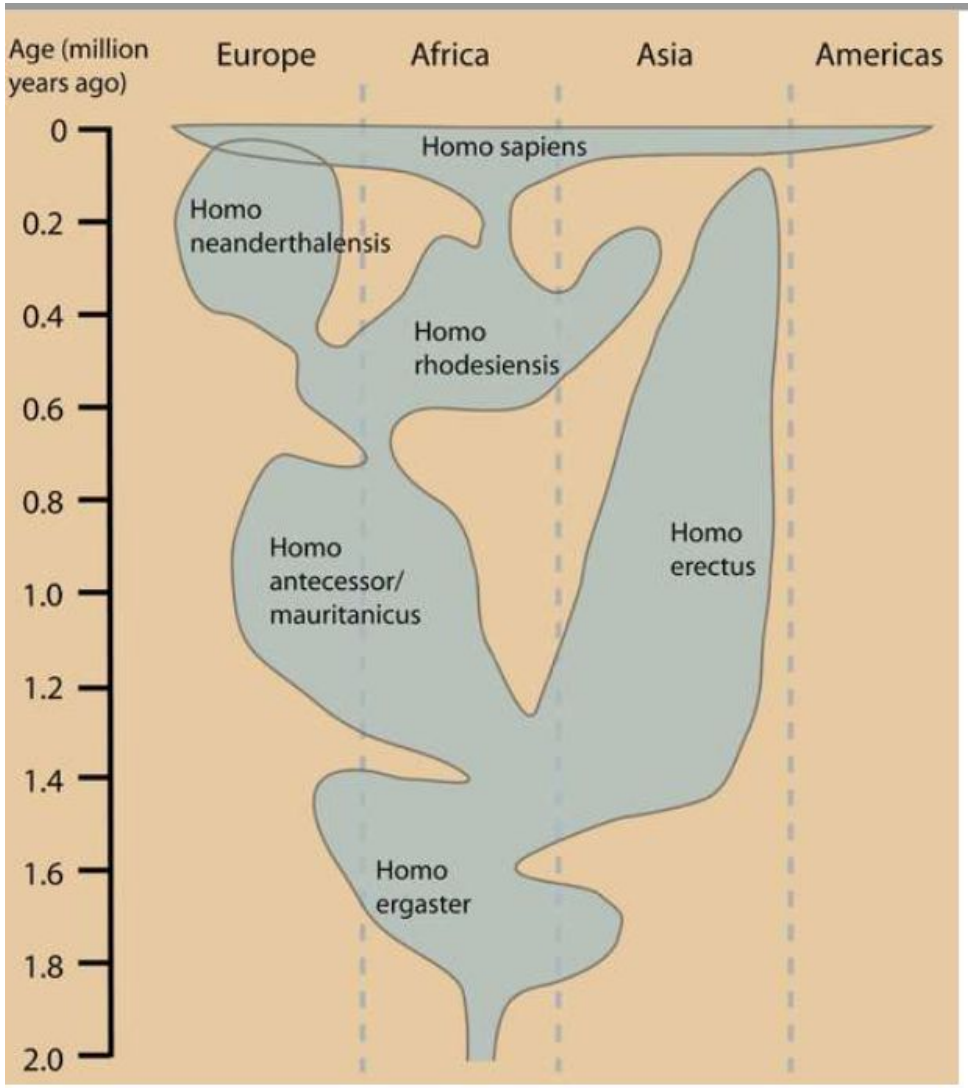


# Evidence


Coronal Suture
Frontal
Brow
Nasal
Sphenoid
Maxilla
Mandible
Parietal
Squamous Suture
Lambdoid Suture
Occipital
Temporal
Mastoid Process
Zygomatic


The jaw has developed from a U into a V shape. Teeth have generally reduced in size. (Chimpanzee provided for comparison)


# **Hybrid** – two different species that mate, producing **sterile** offspring.



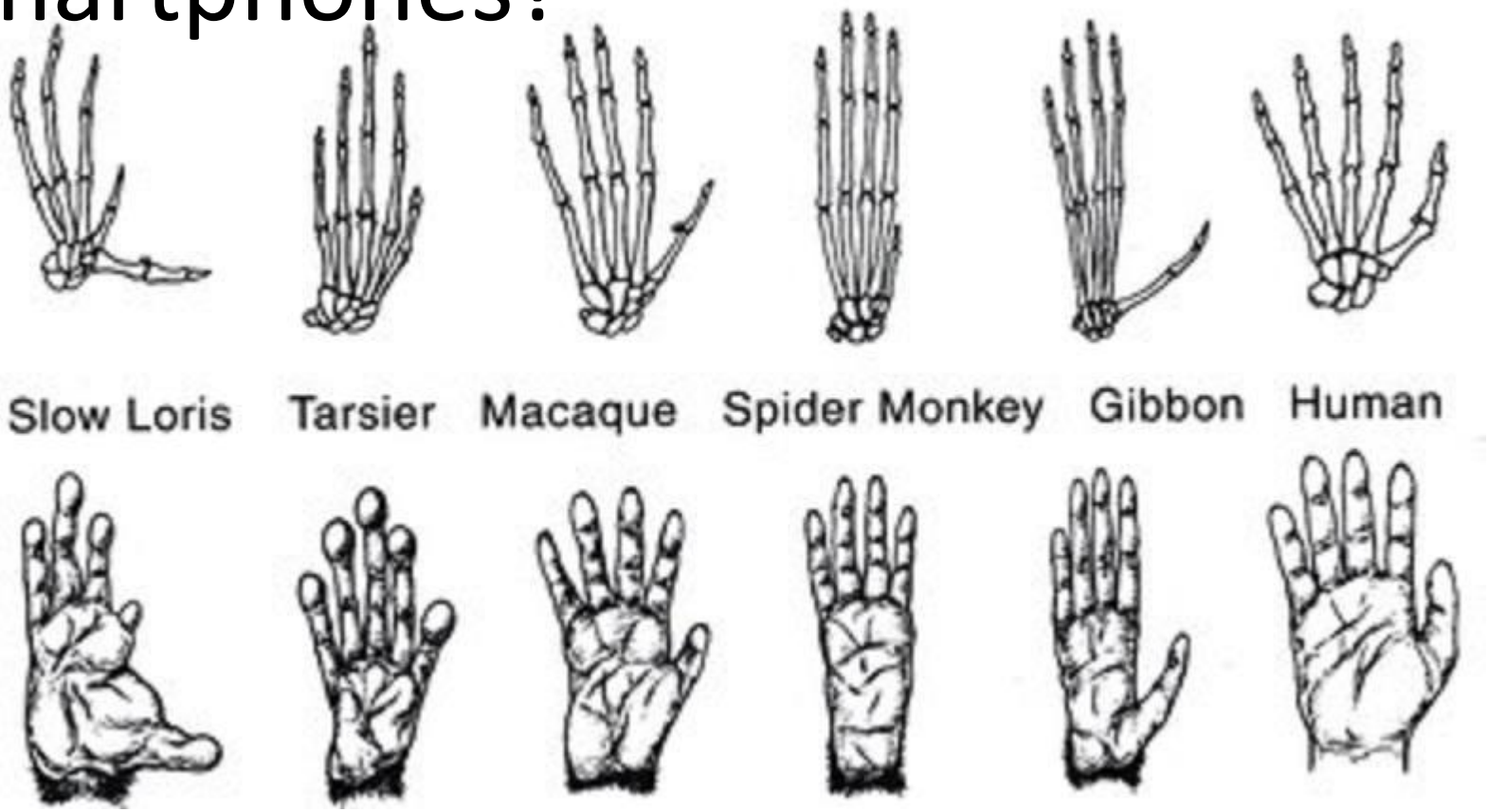

Note that according to this interpretation of the fossil record *Homo sapiens* is not descended from *Homo erectus* or *Homo neanderthalensis.*

However, some postulate that *Homo sapiens* may have hybridised with *Homo neanderthalenis.*

This could have contributed to the disappearance of the neanderthals in much the same way that indigenous animals like dingos are in danger of extinction due to breeding with domestic dogs.

# Hands **selected for** smartphones

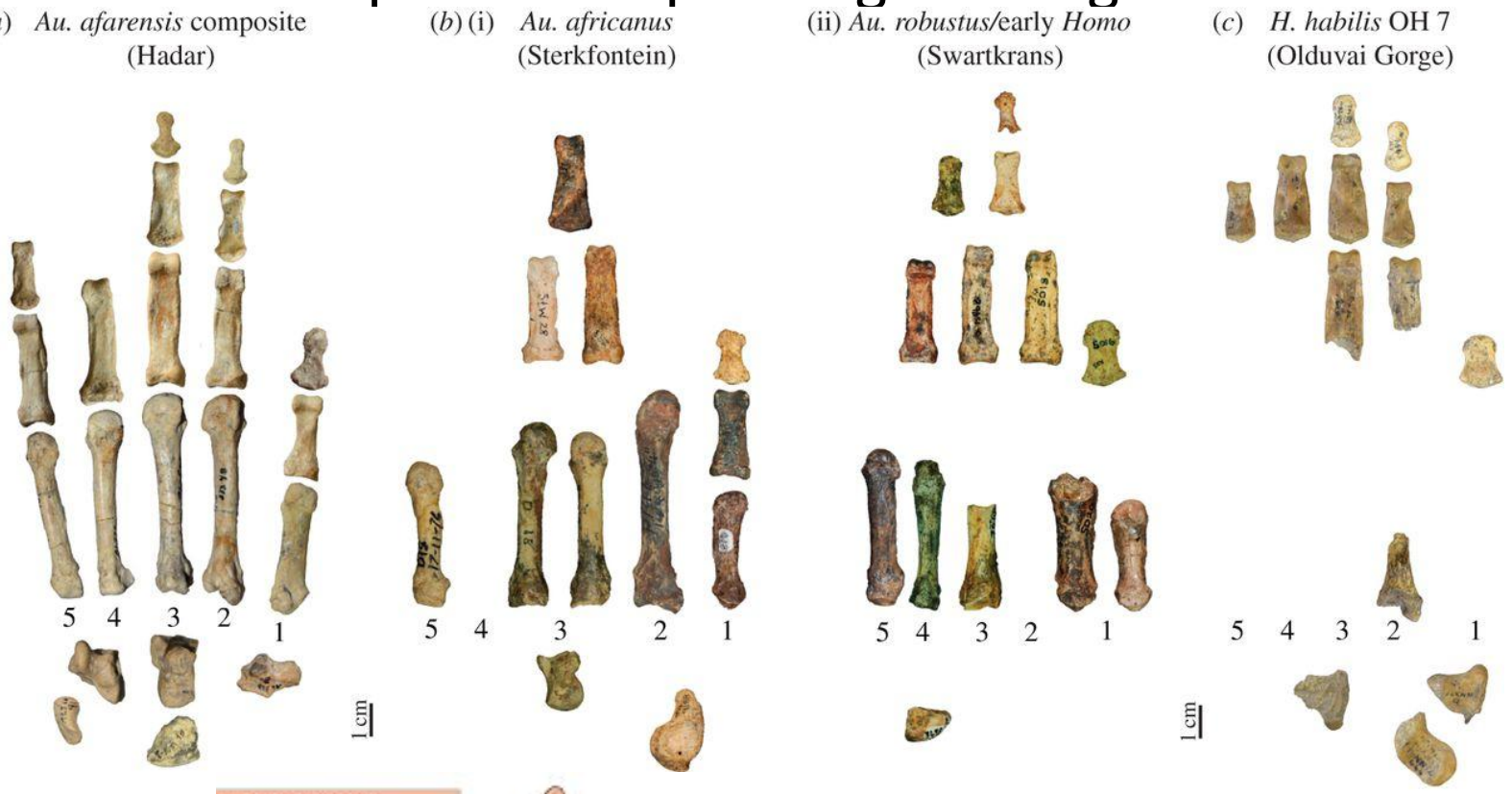
# Which hands are **selected against** smartphones?

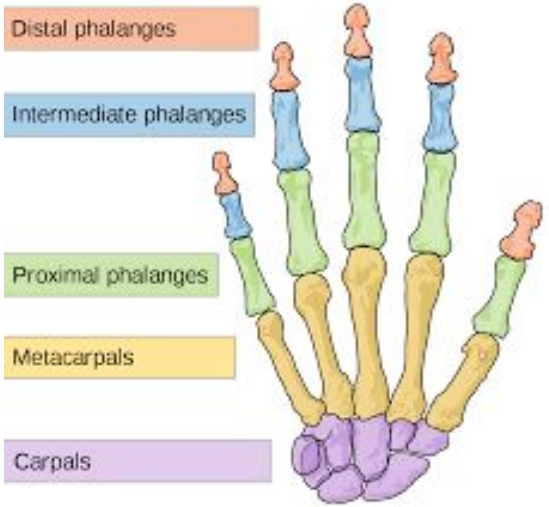


# Opposable Thumbs


Tools
https://www.handprint.com/LS/ANC/stones.html

# Evidence: Comparison of phalanges – finger bones



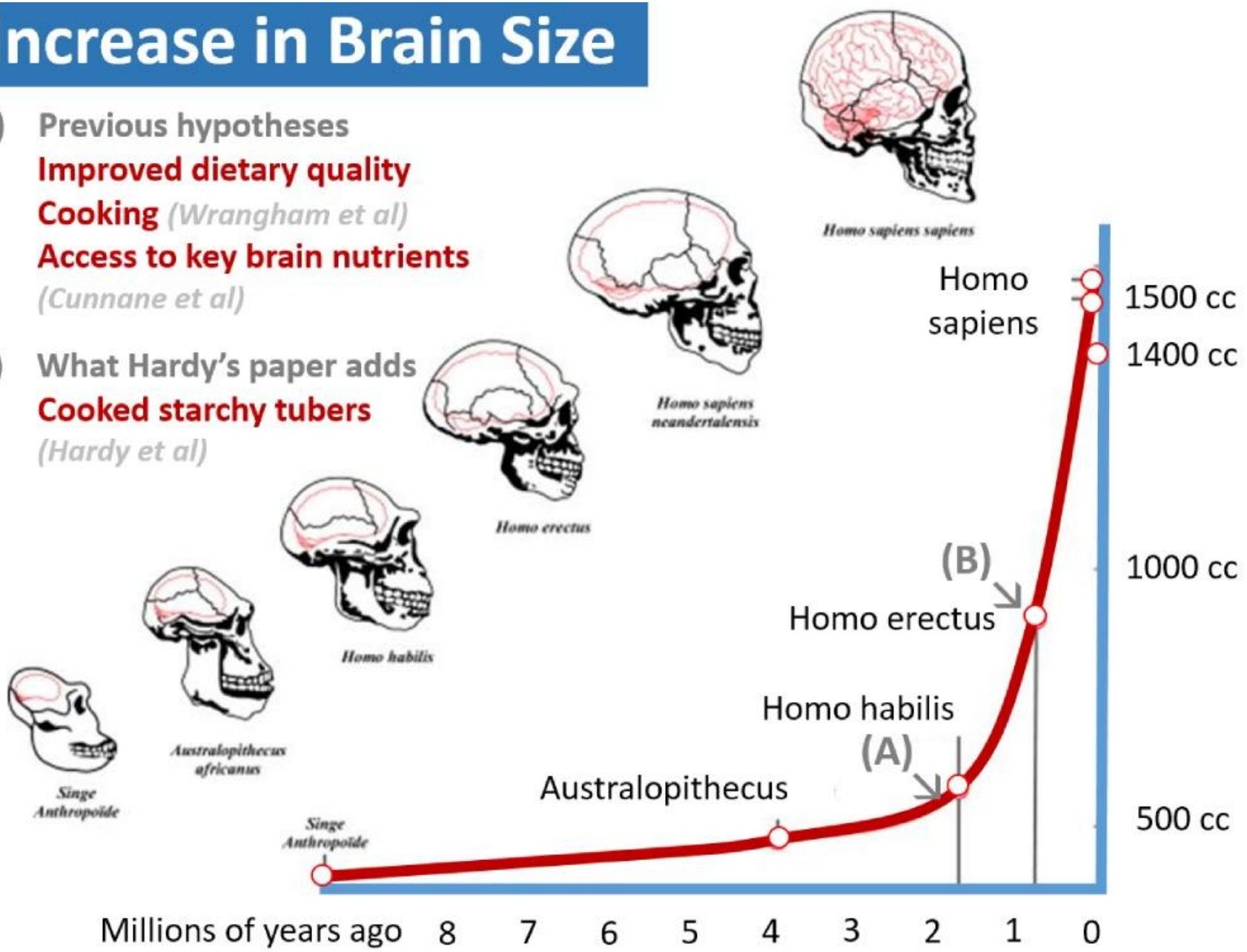
# Increase in Brain Size

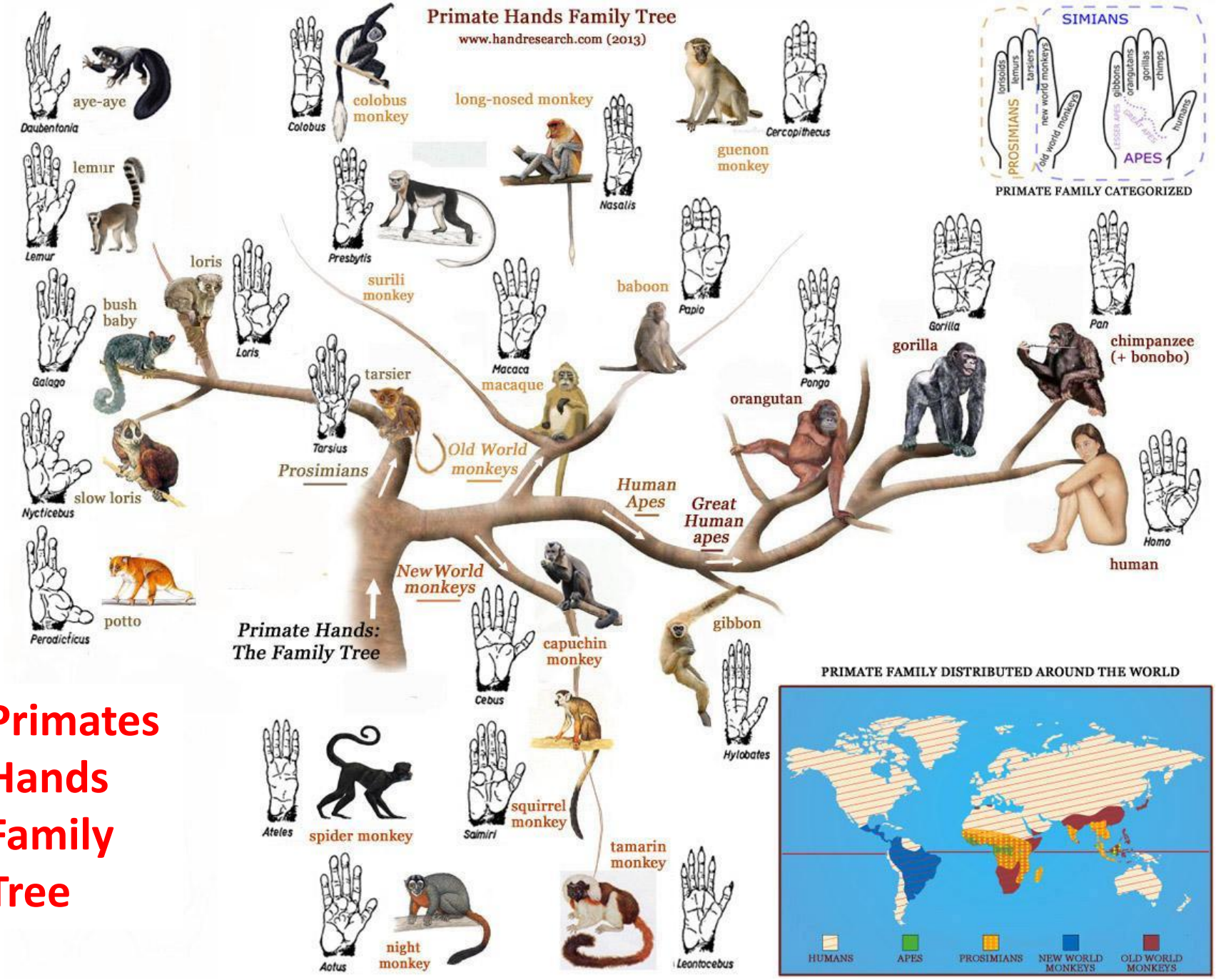
A) Previous hypotheses

- **Improved dietary quality**
- **Cooking** *(Wrangham et al)*
- **Access to key brain nutrients** *(Cunnane et al)*

B) What Hardy's paper adds

- **Cooked starchy tubers** *(Hardy et al)*






# Primates Hands Family Tree

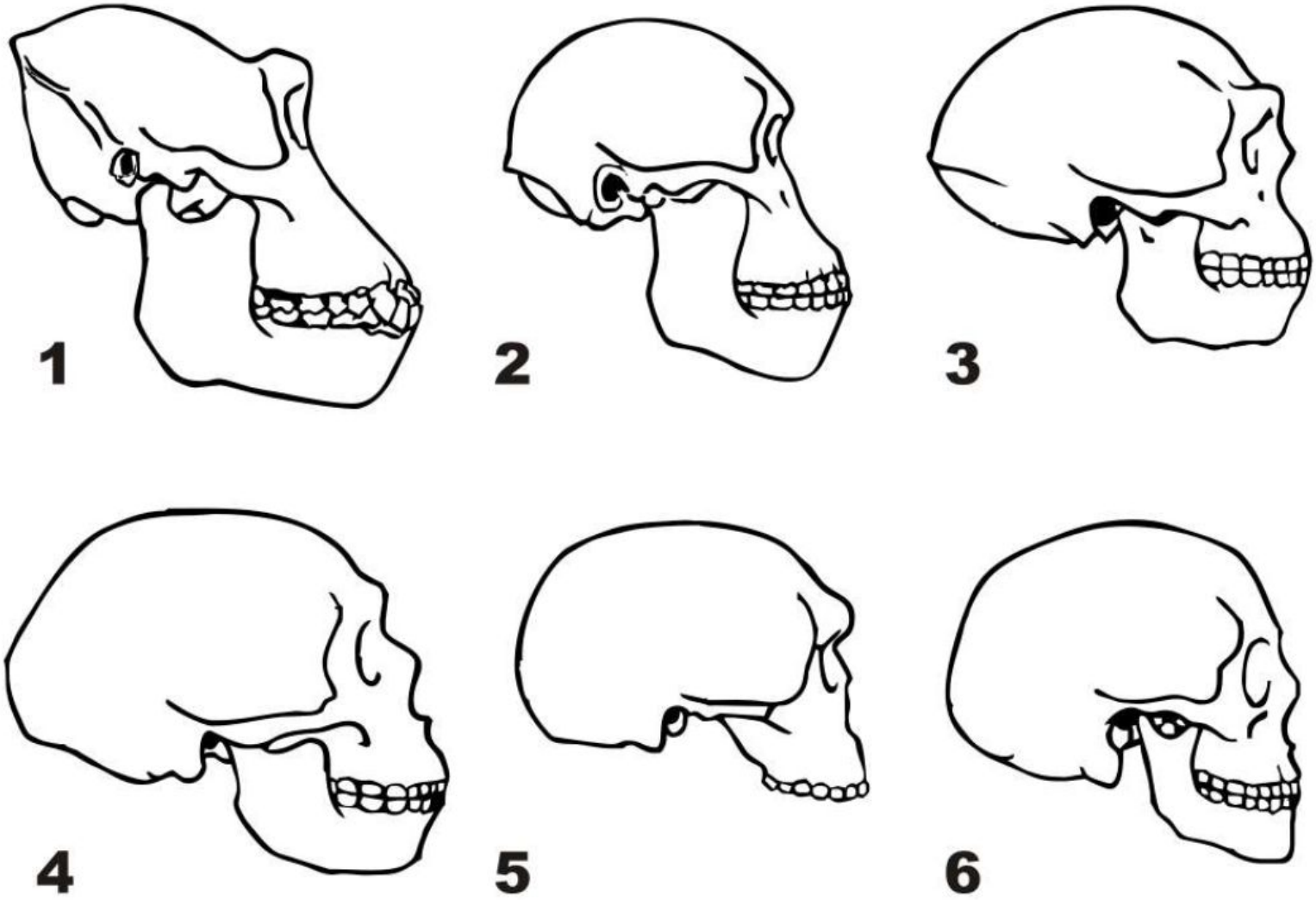



# Grasping pentadactyl limbs

http://www.flickr.com/photos/johnkay/5901639745/
http://www.flickr.com/photos/shannonkringen/5466678956/
http://www.flickr.com/photos/grendelkhan/1160017887/

Human hands are adapted for grasping and fine manipulation. In contrast gorillas have short fingers for knuckle walking and gibbons have elongated fingers and reduced thumbs for brachiating.

http://www.flickr.com/photos/docsearls/5500125757/
http://en.wikipedia.org/wiki/File:Western_Lowland_Gorilla.jpg
http://www.flickr.com/photos/cskk/2709688102/




1. Gorilla
2. Australopithecine
3. Homo erectus
4. Neanderthal (La-Chapelle-au-Seine)
5. Steinheim Skull
6. Modern human

http://commons.wikimedia.org/wiki/File:Craniums_of_Homo.sv

# Skeleton, locomotion and posture

Human knees aligned under the body's centre of gravity because femurs are angled inwards.
Human legs straighten completely when walking.
Human spine has additional curves to keep centres of mass of head and trunk aligned for bipedalism.
Big toe not opposable in humans,
which allows for an arched foot.
Ratio legs:arms greater for humans than other apes
Human pelvis broader

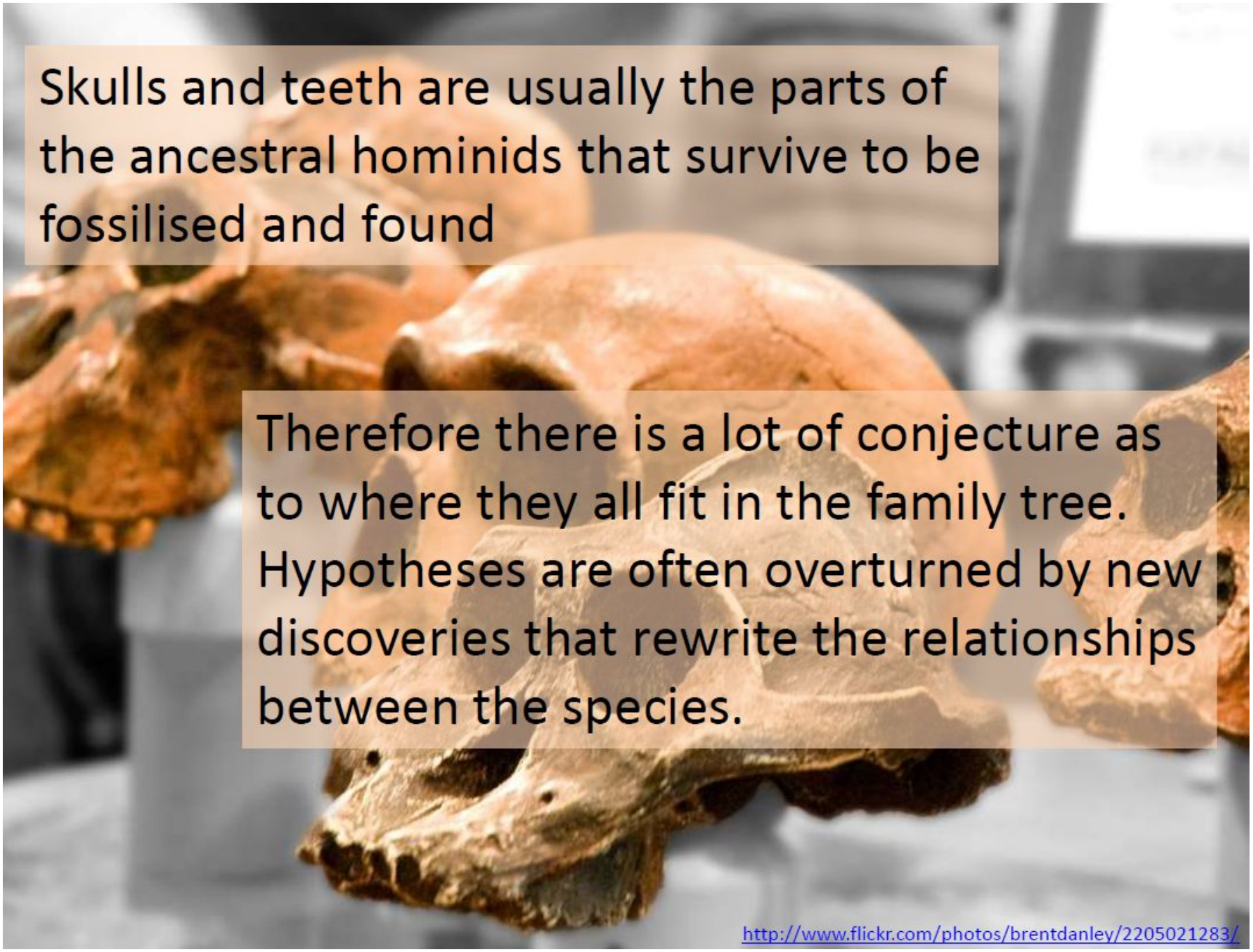
# Some characteristics are thought to be a result of neoteny: when juvenile characteristics are retained by the adults of a species

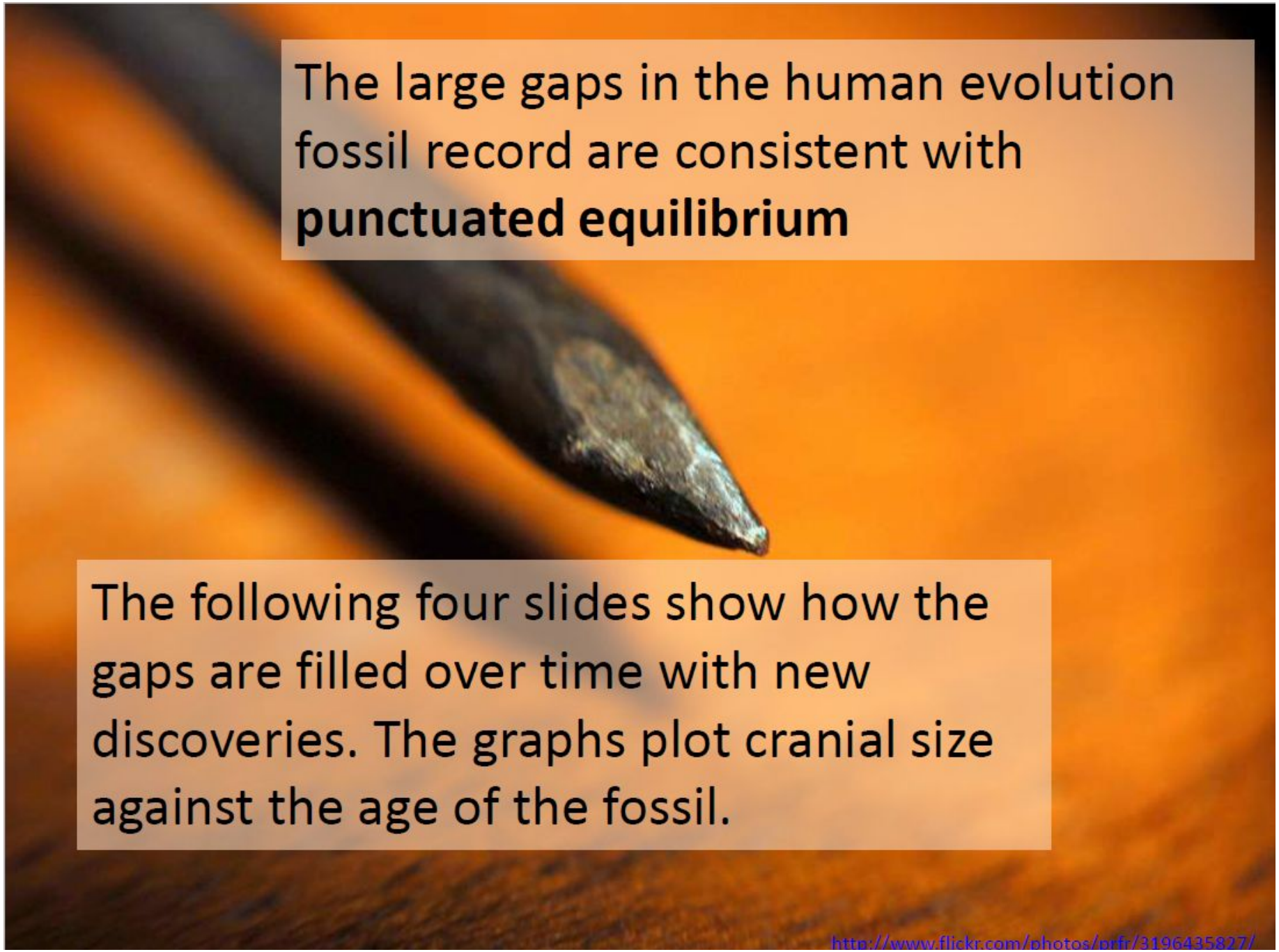
Some human characteristics thought to be a result of neoteny.

- Lack of body hair
- Small teeth and reduced numbers of teeth
- Prolonged growth period
- Long life span
- Flat face and thin skull bones
- Lactase production in adults
- Epicanthic eye fold
- Small nose
- Longer trunk relative to arms and legs

It isn't easy to create a collection of fossils that clearly show the change of species from one to another. Fossils rarely result when an animal dies for the following reasons:

- Decomposition is usually rapid; soft body parts are rarely fossilised
- Scavengers usually break up skeletons and even chew up bones
- The conditions have to be just right for fossilisation to occur.
- Only a tiny, tiny, tiny fraction of all of the fossils in existence have been found.


Skulls and teeth are usually the parts of the ancestral hominids that survive to be fossilised and found
Therefore there is a lot of conjecture as to where they all fit in the family tree. Hypotheses are often overturned by new discoveries that rewrite the relationships between the species.
http://www.flickr.com/photos/brentdanley/2205021283/



The large gaps in the human evolution fossil record are consistent with **punctuated equilibrium**

The following four slides show how the gaps are filled over time with new discoveries. The graphs plot cranial size against the age of the fossil.

Despite the fossil evidence we have so far, there are still large gaps in our knowledge

We have no fossil for the last common ancestor of humans and chimpanzees

It is believed to have lived 6-8 million years ago

*Find out how this estimate was determined*

http://www.flickr.com/photos/owenbooth/126288240/

The benefits of a bigger brain include:

- More complex tools
- Mastery of fire
  - Cooking
  - Wamth
  - Protection
- Greater behavioural flexibility (less reliance on instinct and better able to learn and pass on knowledge necessary to adapt to an environment)

http://madsenworld.dk/anigif/light/flames.gif
http://commons.wikimedia.org/wiki/File:Miscellaneous_stone_tools.jpg

The cost of having a big brain:

- Longer gestation period
- Years of development before young can look after themselves
- Much more brain development occurs post birth that for any other animal

In summary: Big brains are energetically expensive. The mother must take in lots of energy not only during pregnancy, but for a significant time after.

Hominids needed to increase their energy uptake.

http://www.flickr.com/photos/superbomba/2288271254/


The solution to this energy crisis was to swap a diet of these:
http://www.flickr.com/photos/heydrienne/22080973/

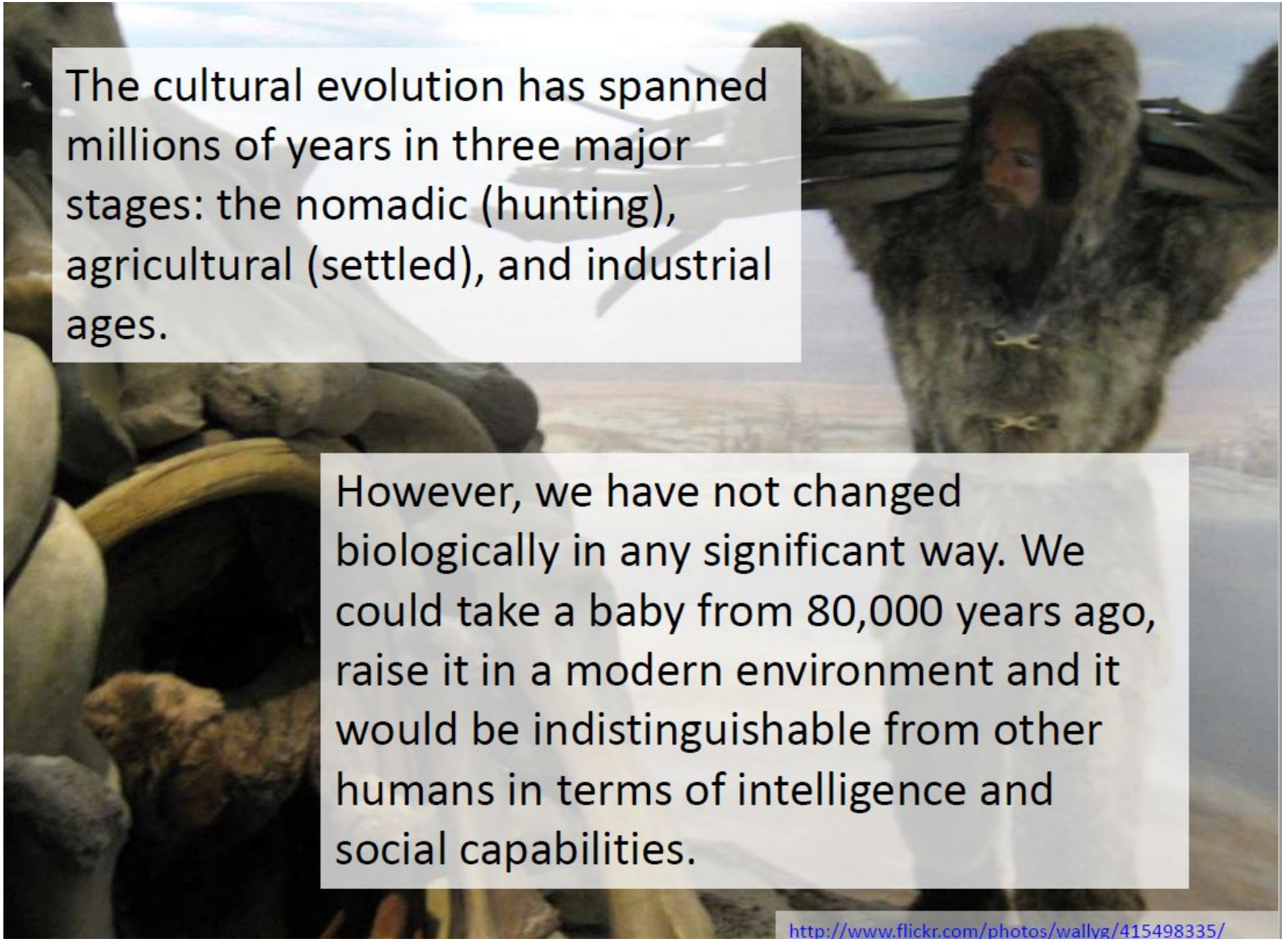
# For some chunks of this:

The increase in brain size observed in hominid fossils has been closely correlated with an increased intake of meat.

A bigger brain made hunting and killing easier

Well gosh, we know all about **genetic evolution** by now! In this context it refers to the genetic changes that have occurred during the evolution of hominids. e.g. increased brain size, spine shape, position of knee

**Cultural evolution** is the changing of ideas held and actions carried out by societies and the transmission of these ideas through social learning from one generation to the next.
e.g. the use of fire, agriculture, tools, weapons, religion, beliefs



The cultural evolution has spanned millions of years in three major stages: the nomadic (hunting), agricultural (settled), and industrial ages.

However, we have not changed biologically in any significant way. We could take a baby from 80,000 years ago, raise it in a modern environment and it would be indistinguishable from other humans in terms of intelligence and social capabilities.

http://www.flickr.com/photos/wallyg/415498335/

# Student notes – next four slides

# Human Evolution: Primate Ancestors

| Adaptations of Primates | |
|---|---|
| **Prehensile limb** | Highly mobile digits (fingers) and the first digit can oppose (touch –tip to tip) allowing for a powerful grip |
| **mobile forearm** | Clavical and scapula are adapted to allow a wide range of movements. Moving tree to tree, transfering food to mouth. |
| **Stereoscopic vision** | Ability to judge distances, forward looking eyes with overlapping fields of view. (adaptation -flattening of face) |
| **Reduced sense of smell** | Associated adapations due to flattening of the face , development of steroscopic vision, and increased use of facial muscle. |
| **Unspecialised digestive system** | Unspecialized teeth and guts allow a wide variety of food sources. --herviorous diet changed to omnivours diet. |
| **Skull modified for upright posture** | Large foramen magnum (lopening for brain stem) - upright posture and forward-looking face. |
| **Reduced number of offspring** | Adapted strategy of young clinging to mother's body and slowely develop. Long gestation and long dependency after birth. |
| **Large brain** | Aboreal living required excellent coordination, vision, tactile sense, memory thought and learning – large and developed brain. |
| **Social** | Primates live in social groups, probably stemming from the mother-child long |

## Classification of humans

Kingdom Animalia

Phylum Chordata

Class Mammalia

Order Primate

Suborder Anthropoid

Superfamily Hominoid

Family Hominid

*Genus Homo*

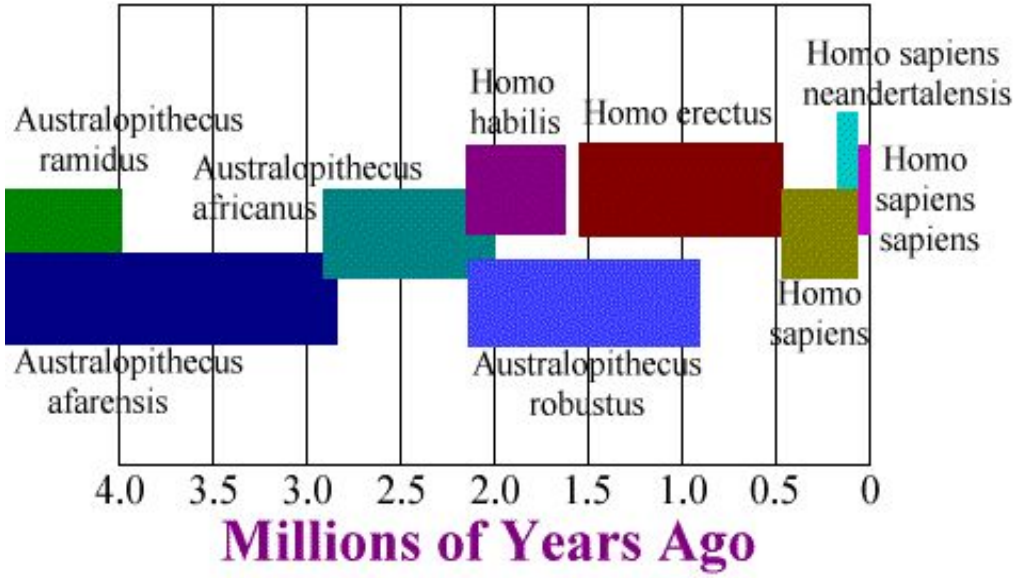
*Species sapiens*

**Groups of Modern Primates**

-about 65 Million Years Ago (MYA) primative primates diverged to give rise to two main suborders

Promisians – meaning 'before apes' Today : lemurs, lorises, tarsiers

Anthropoids – meaning 'ape form' Today: monkeys, apes, humans



## FROM AUSTRALOPITHECUS TO HUMANS TODAY

### AUSTRALOPITHECUS (Hominid)

- Height: 1.10 m
- Weight: 40 kg
- Walked upright

### HOMO HABILIS

- Height: 1.59 m
- Weight: 50 kg
- First tools
- Could speak

### HOMO ERECTUS

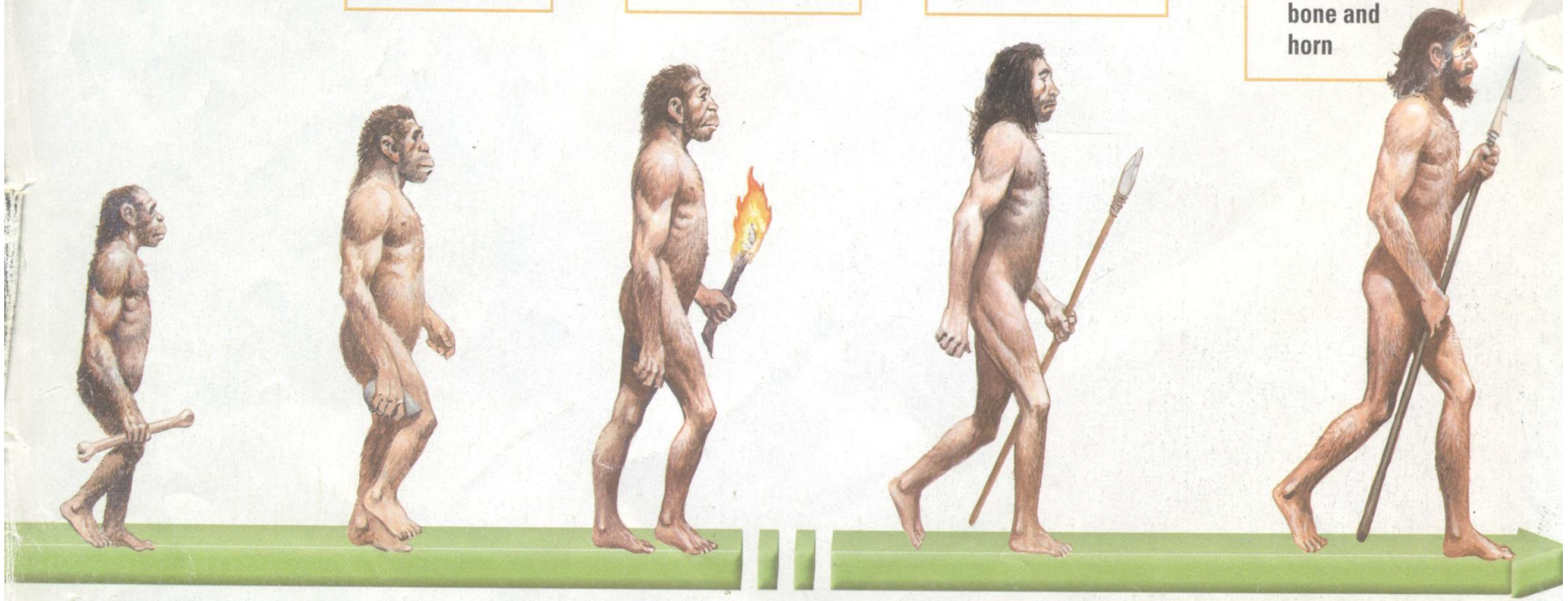
- Height: 1.60 m
- Weight: 60 kg
- Discovery of fire
- Hunted in groups

### HOMO NEANDERTHALENSIS

- Height: 1.65 m
- Weight: 80 kg
- First burials
- Specialised tools

### HOMO SAPIENS SAPIENS

- Height: 1.70 m
- Weight: 70 kg
- Examples of art
- Tools made of bone and horn



3500000 / 2500000 years ago

2300000 / 1800000 years ago

1900000 / 400000 years ago

150000 / 35000 years ago

120000 years ago (40000 years ago in Europe)

**Questions 20,10**

1. Explain why the following adaptations are important.

   A. Reduced sense of smell

   B. Opposable thumb

   C. Stereoscopic vision

   D. Skull modified for upright posture

2. What is the heirarchy of modern man?

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

3. What is our scientific name (bionomial nomenclature)

   _____

4. The original wild ancestor the modern apple was found growing wild in the mountains of southern Kazakhstan. Which of the following names for this apple is written following the rules of bionomoial nomenclature?

A. Malus Sieversii B. *Malus Sieversii*

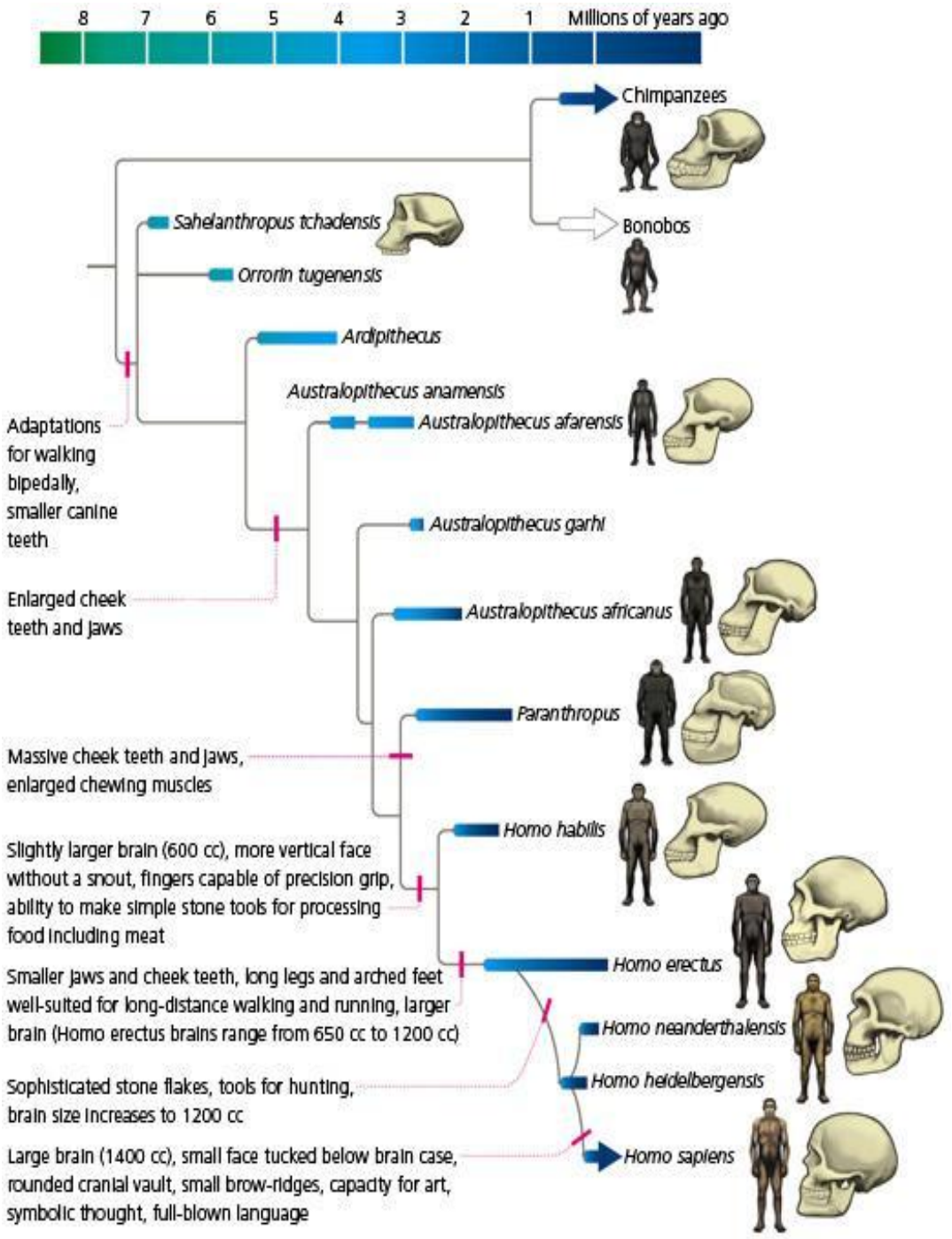
C. *Malus sieversii* D. Malus sieversii

5. Write the scientific name of man, using the rules of binomial

   nomenclature. _____

6. What does arboreal life mean? _____

   _____



# BIGGER BRAINS, MORE INTELLIGENT, BETTER TOOLS

**Australopithecus**
- 4.5-2.0 million years ago
- Lived in Africa
- Walked on two feet
- Free hands
- First to use stone
- tools
- Varied diet: hunting and gathering
- Meat eaters ( more protein = bigger brains)

**Homo Habilis**
- 2.3-1.6 million years ago
- First HUMAN
- Lived in Africa
- First to make stone tools
- Varied diet: hunting and gathering
- Bigger brains
- Tries to understand its environment

**Homo Erectus**
- 2 million – 300,000 years ago
- Migrations: lived in Africa, Asia and Europe
- Discovered fire and how to use it
- Varied diet: hunting and gathering
- Excellent hunter
- Lived in organized groups
- Specialization of labour: hunters, tool makers, gatherers

**Homo Neanderthalensis**
- 150,000 – 30,000 years ago
- Lived in Europe
- First to bury their dead
- Adapted to cold weather (warm clothes)
- Strong and resistant body
- Lived in organized groups
- Variety of tools; burials

**Homo Sapiens**
- 120,000 years ago
- Origin: Eastern Africa, then migrated to other continents
- Adapted to variety of conditions
- Taller, slimmer and more intelligent
- Made better tools with variety of materials: stone, bone, horn
- Take advantage of all kinds of resources
- Complex language
- Art

- Specific notes on 5 species of stages of anthropogensis

# Genus Australopithecus

The *Australopithecines* are early hominins existing between 4.4-1.2 mya.

There are up to 10 species and three genera (*Australopithecus, Ardipithecus, Paranthropus*), depending on the view of the particular paleoanthropologist.

- They are the first known habitually bipedal primates
  - *(mixed skeletal traits suited for arboreal and bipedal locomotion)*
- Suited to herbivorous diet
- Small brains.
- No evidence of stone tool use.

*Draw a rough timeline of these early hominins.*

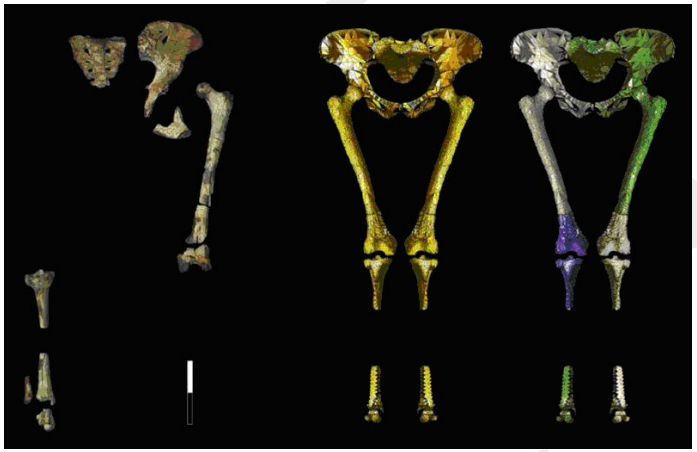
- *Ardipithecus ramidus* (4.5-4.2 mya)
- *Australopithecus anamensis* (4.2-3.8 mya)
- *Australopithecus afarensis* (3.9-3 mya)
- *Australopithecus africanus* (3-2.3 mya)
- *Australopithecus / Paranthropus robustus* (2.2-1.5 mya)
- *Australopithecus / Paranthropus boisei* (2.2-1 mya)

# *Australopithecus afarensis* (3.9-3 mya)

An **40% complete skeleton** was found in Ethiopia in the 1970s and came to be known as **'Lucy'**.

'Lucy' and other fossil evidence gave clear evidence of **full bipedalism**. There are also **primitive features**:

- small brain 440cm$^3$, similar to chimp
- large canine teeth with diastema present
- Long arms relative to legs
- Increased valgus angle
- jaws more parallel like apes
- long and slightly curved finger bones.
- Prognathism (jutting out of lower face).
- Receding chin
- Footprints showing bipedalism



# *Australopithecus africanus*
(3-2.3 mya)

**Fossil remains** (South Africa), included the skull of a child about 3-4 years old named the ‘”Taung child’.

- Foramen magnum indicated bipedalism
- Small canine teeth without a diastema
- parabolic-shaped jaw more human than apelike
- Small brain 440cm$^3$
- Hip girdle more humanlike than apelike

# *A.robustus* (2.2-1.5 mya)
# *A.boisei* (2.2-1 mya)

These two species are placed in the ***Australopithecus*** genus by many scientists and the genus ***Paranthropus*** by all the others.

They are more robust (heavily built) than the other *Australopithecine* species.

- heavy skull with massive molars and premolars
- large sagittal crest
- large zygomatic arch indicating large jaw muscles for eating tough fibrous plant material (hence the given name 'nutcracker man' for *A.boisei)*

# Which was our ancestor?

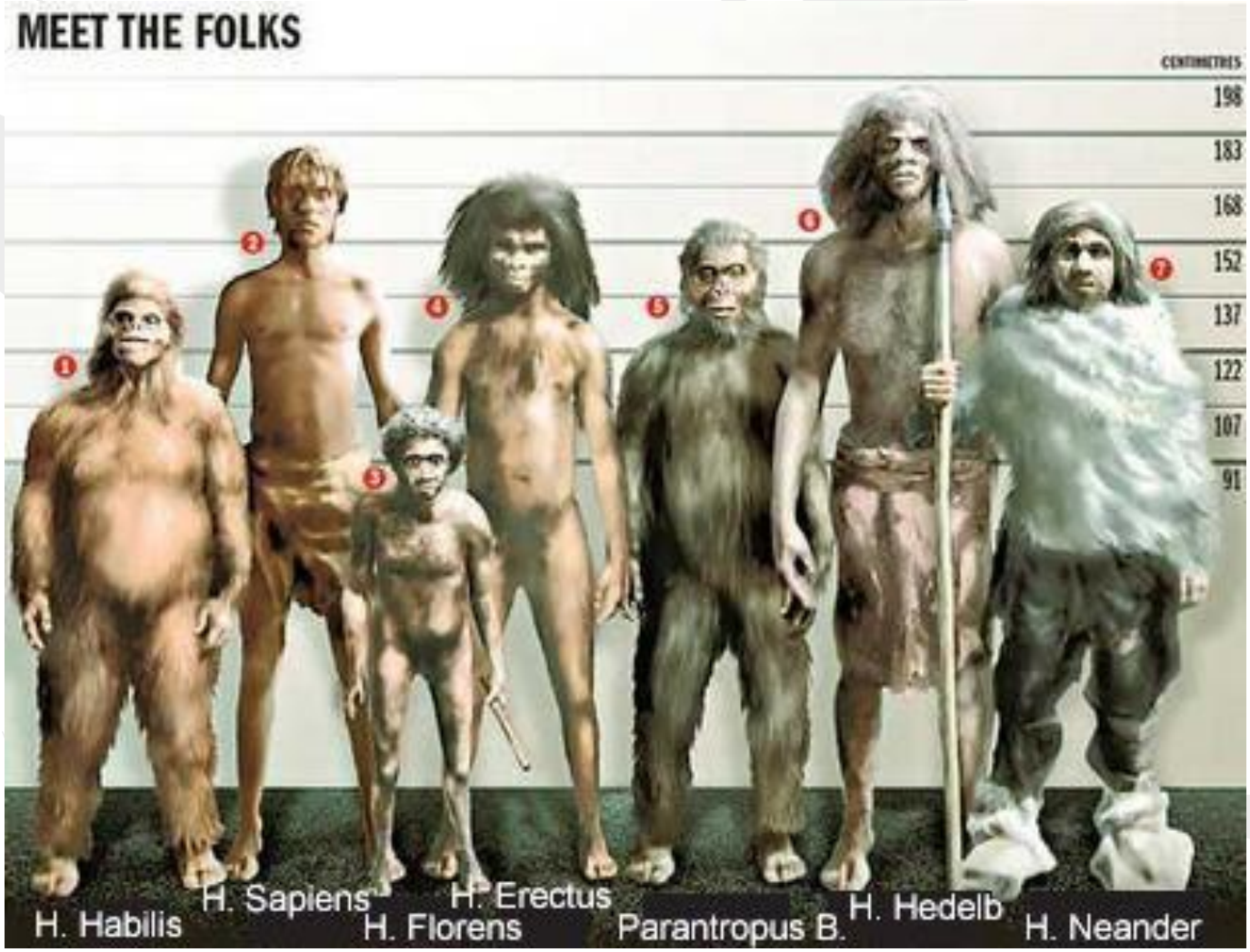
It is generally agreed that:

- A.anamensis and A.afarensis were likely to have been ancestral to Homo genus
- A.ramidus was likely to have been close to the ancestor of both humans and apes
- Australopithecus/Paranthropus robustus and boisei were specialised herbivorous forms that were evolutionary dead ends; i.e left no present-day descendants.

# The later hominins

*Homo genus: The other homo species and H. sapiens*

# Genus Homo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H. Habilis
H. Sapiens
H. Florens
H. Erectus
Parantropus B.
H. Hedelb
H. Neander

# Genus Homo

The *Homo* genus came into existence approximately 2.5 mya.

There have been many species in this genus, but only one species, ours, *Homo sapiens*, survives. Other species we know of were; H. habilis, H. ergaster, H. erectus, H. floresiensis, H. antecessor, H. georgicus, H. heidelbergensis, H. neanderthalensis

With the genus *Homo* there was a sudden leap in brain size, a change in anatomy and the beginnings of stone tool culture and other cultural advances.

**Back Story** | WHO'S WHO IN THE GENUS *HOMO*

Scientists think the *Homo* genus evolved 2.3 million years ago. The discovery of 1.7-million-year-old skulls in Georgia, though, has caused confusion about the genus's direct ancestor and relationships among *Homo* species.

***H. erectus***
Bones of 50-plus *H. erectus* individuals dating from 300,000 to 800,000 years ago have been found at sites in Java and China.

***H. heidelbergensis***
Evidence for this species, dating to at least 350,000 years ago, comes from across Europe. Most believe it is an ancestor of Neandertals.

***H. floresiensis***
A partial skeleton and other bones found on Flores have led some scientists to propose this species. It may have lived until just 17,000 years ago.

***H. neanderthalensis***
After their ancestors left Africa, Neandertals spread across Europe, the Middle East and into Siberia before going extinct 30,000 years ago.

***H. sapiens***
Modern humans are the only living members of the *Homo* genus. They may have lived near other hominids 40,000 years ago.

# Another climate change

At about 2.5 mya (when *Homo* genus first came to exist), Africa underwent more dramatic climate change, and the habitat that had been occupied by early hominins became more open and arid.

This led to a change in the type of plant species that were successful - tougher foods that could withstand the drier conditions, such as roots and tubers became more prevalent.

# *H. habilis / H. rudolfensis*
## (2.3-1.44 mya)

*Homo habilis* is almost transitional between the *Australopithecines* and *Homo* species.

Had a body with longer arms like Australopithecines, but a more human like face that was longer and narrower and less protruding.

Its teeth were smaller with a lighter jaw curved more like modern humans. It's skull was more rounded.

It's brain size was about 600-800 cc, about 50% bigger than Australopithecines, but still smaller than modern humans (1000-1800 cc).

About 1.3m tall.

*H.habilis either lived at the same time as H. rudolfensis (more robust) or they may be the same species.*

# *H. ergaster/ H. erectus*

## (1.9 mya - 100,000ya)

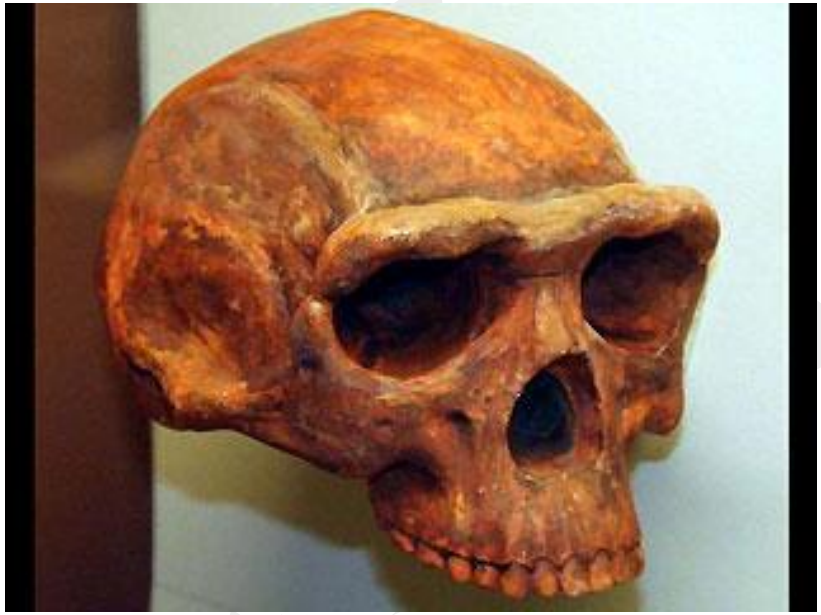
*Whether H. ergaster and H.erectus are two species or one is uncertain. H. ergaster (who remained in Africa) may have diverged from H. erectus (who migrated to Asia), or they may be different populations of the same species, H. erectus, living in different areas.*

*The African population is believed to be the ancestor of later Homo species H. heidelbergensis, H. neanderthalensis and H. sapiens (us).*

Both contained a larger brain than *H. habilis* of 750 - 1250 cc

About 1.6m tall.

They had a flatter face but large brow ridges, large jaw and no chin.



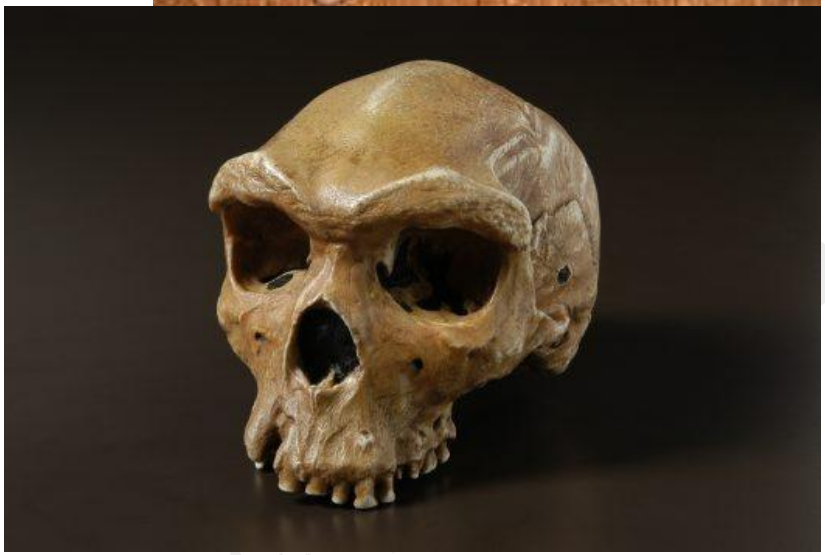
# *H. heidelbergensis*
## (600,000-400,000ya)

Descendant of H. ergaster/erectus.

They had a prominent brow ridge (but smaller than *H.erectus*).

Tall at 1.8m on average and more muscular than modern humans (some were believed to be up to 2m tall with weights of 100kg)

Brain capacity between 1100-1400 cc *(which overlaps that of modern humans 1000-1800 cc)*



# *H. neanderthalensis*

## (400,000ya - 30,000ya)

Like modern humans, Neanderthals (pronounced with a silent h, 'Nee-an-der-tal'), were members of the *Homo* genus. They looked different because they evolved in cold (European) climates and had adaptations to conserve heat.

Short stocky bodies that were very muscular.

Large head with huge projecting nose and deep set eyes under a prominent brow ridge and a sloping forehead.

Averaged heights of 1.5-1.7m tall.

Largest brain capacity of *homo* species of 1500 cc.

# *H. sapiens*

## (200,000 ya - present)

Anatomically, modern *H.sapiens* evolved from *H. heidelbergensis* in Africa.

Due to warmer climates, unlike the *Neanderthals, H. sapiens* are tall and lanky with a more gracile (lightly built) skeleton.

Height varies from 1.5-1.8m.

Brain capacity ranges from 1000-1800 cc

We have a flat rather than sloping forehead with only a slight brow ridge.  Small nose and jaw with a definite chin.

Jaw is v shaped with small uniform teeth suited for omnivorous diet.

Want to know more? Look in the mirror.