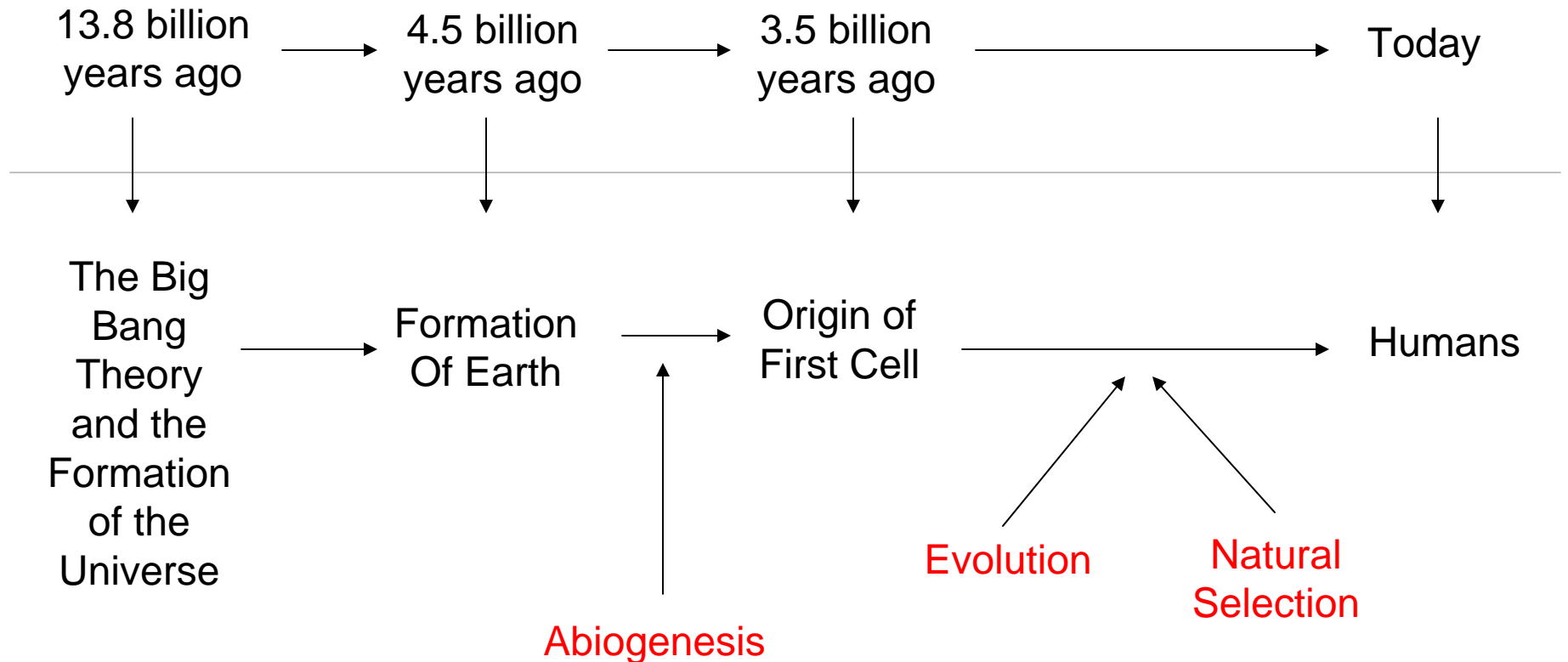


The Cell Theory, Evolution & Natural Selection

A Primer About How We Came To Be

The Forces That Created Life

Physics – Chemistry - Time

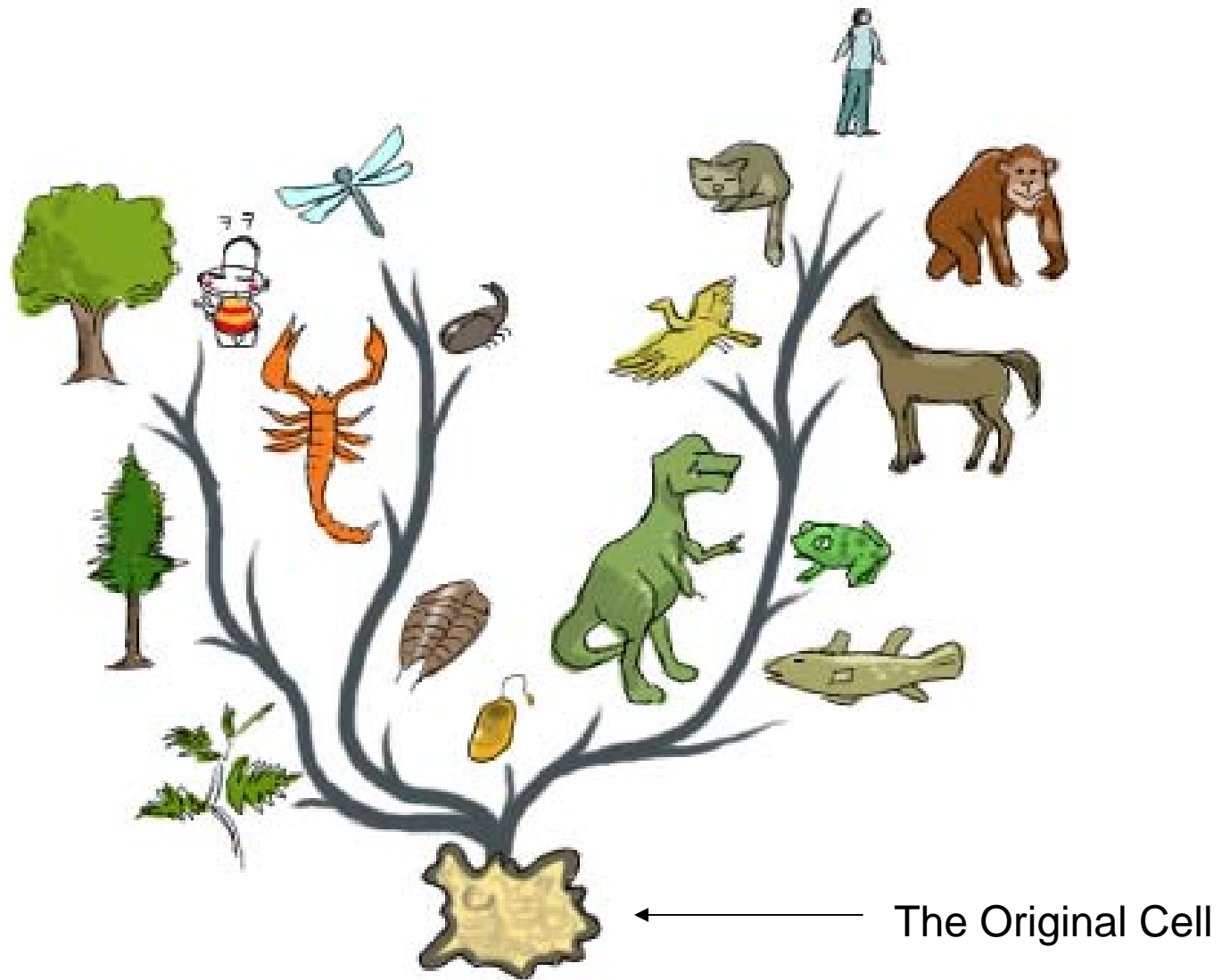


How We Came To Be

- **Abiogenesis** is a scientific theory which states that life arose on Earth via spontaneous natural means due to conditions present at the time Earth was formed. In other words, life came from non-living matter.

In 1953 Stanley Miller sought out to answer the question of the origins of life on Earth. In his experiment he used an apparatus with a flask filled with water and chemicals thought to exist on primitive Earth. What he found was these chemicals under the right conditions spontaneously formed organic molecules! This experiment suggests that organic molecules could have spontaneously formed on primitive Earth giving way to the first living things.

- **Evolution** in biology is the change in the genetic composition of a population during successive generations, often resulting in the development of new species.
- **Natural selection** is the process in nature by which, according to Darwin's theory of evolution, only the organisms best adapted to their environment tend to survive and transmit their genetic characters in increasing numbers to succeeding generations while those less adapted tend to be eliminated.



Abiogenesis = Formation of highly reduced organic molecules by only physical forces (non-biologic formation)

Modern Cell Theory

(Most Important Theory in Biology)

- All organisms composed of cells and cell products.
- The cell is the simplest structural and functional unit of life.
// cells are alive
- An organism's structure and functions are due to the activities of its cells.
- Cells only come from preexisting cells /// not from nonliving matter. // therefore, all life traces its ancestry to an original cell
- Cells of all species have many fundamental similarities in their chemical composition and metabolic mechanisms.

Key Steps in Evolution of Humans from Single Cell to Today

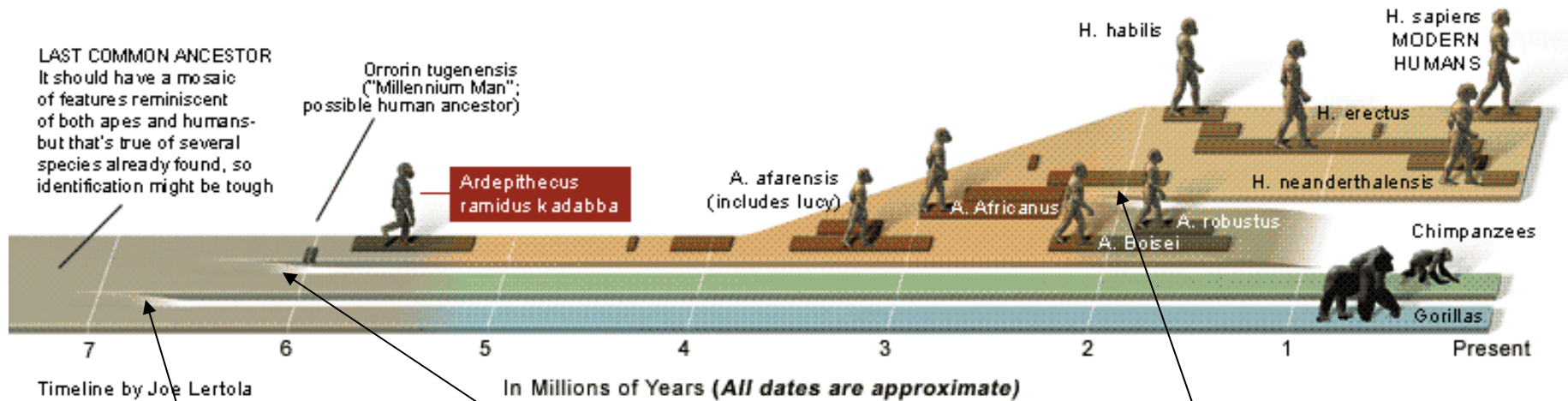
- 13.8 billion years ago (bya) // universe formed (The Big Bang Theory)
- 4.5 bya // earth formed
- 3.5 bya // It took 1 billion years for earth's molten rock to cool and for comets striking earth to fill the oceans with water // period of abiogenesis
- 3.5 bya // first fossil evidence for prokaryotic cells
- 2.5 bya // endosymbiosis
- 2 bya // first fossil evidence for eukaryotic cells
- 2 bya // three domains exist // bacteria – archaea- eukaryotes
- 2 bya // *Grypania spiralis* - first multicellular organism
- 540 – 488 mya // Cambrian Period (Explosion)
- 500 mya // First fish
- 350 mya // insects and plants on land
- 300 mya // First reptiles
- 250 mya // First mammals
- 225 mya // First dinosaurs
- 65 mya // KT Extinction // mass extinction of dinosaurs
- 65 mya // divergence of the primate family tree
- 40 mya / divergence of old world and new world monkeys
- 7 mya // divergence of gorillas and chimpanzees
- 6 mya // divergence of chimpanzees and *Ardipithecus ramidus* (would lead to hominids)
- 4 mya // *Australopithecus anamensis*
- 2 mya // *Australopithecus afarensis* (Lucy)
- 1.75 mya // *Homo habilis* // first hominid
- 1.5 mya // *Homo erectus*
- 750,000 – 40,000 yr ago // *Homo neandertalensis*
- 200,000 years ago // *Homo sapiens* // Today, it is the only surviving hominid, that's us!

Note: Dates are approximate to reference significant evolutionary events. Some events occurred over millions of years and many events co-existed with extended periods of overlap.

Over periods of millions of years different populations of hominids co-existed primarily throughout Africa

A WALK THROUGH HUMAN EVOLUTION

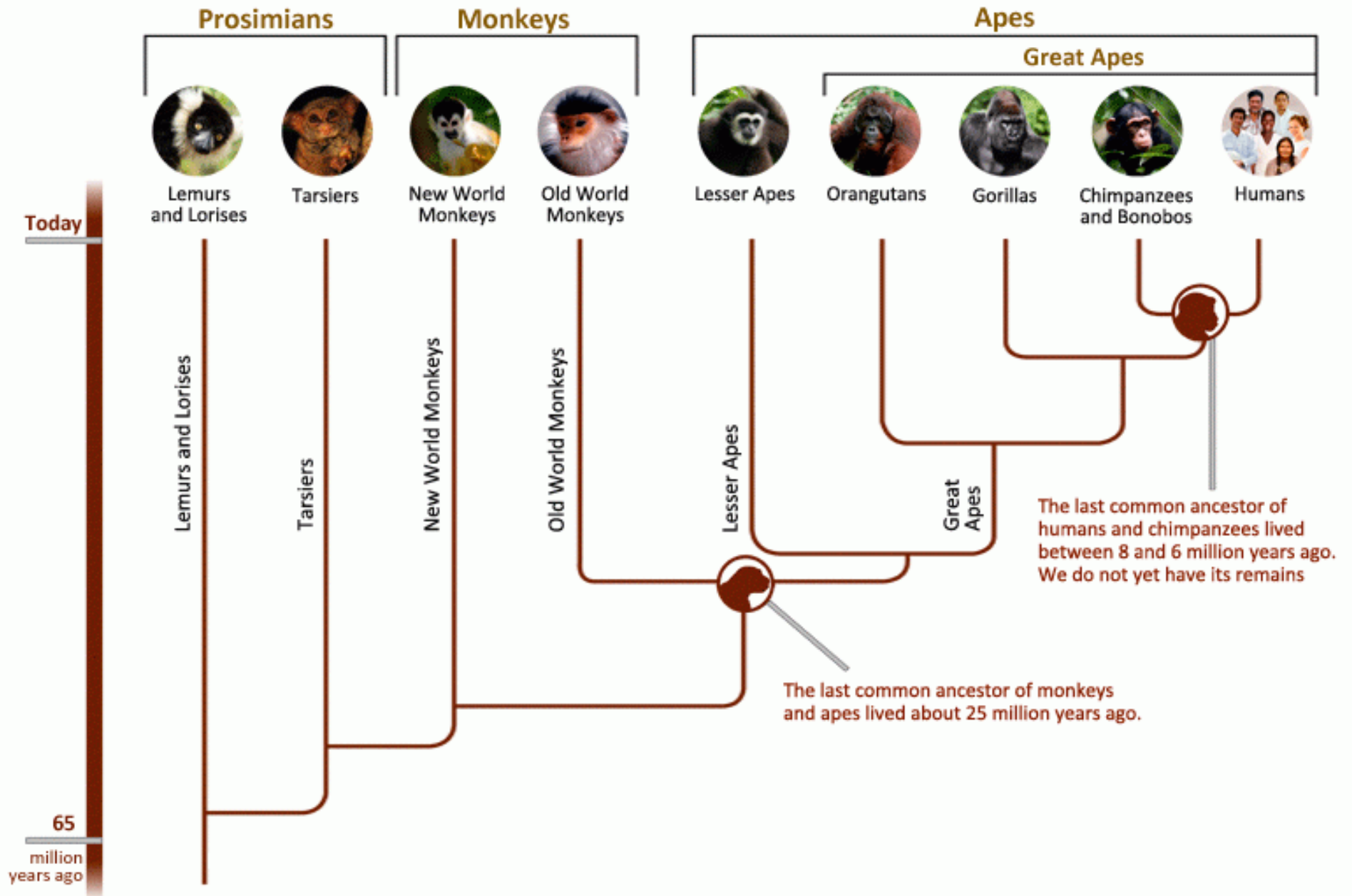
The newest fossils have brought scientists tantalizingly close to the time when humans first walked upright—splitting off from the chimpanzees. Their best guess now is that it happened at least 6 million years ago



Gorillas and Chimpanzees Divergence

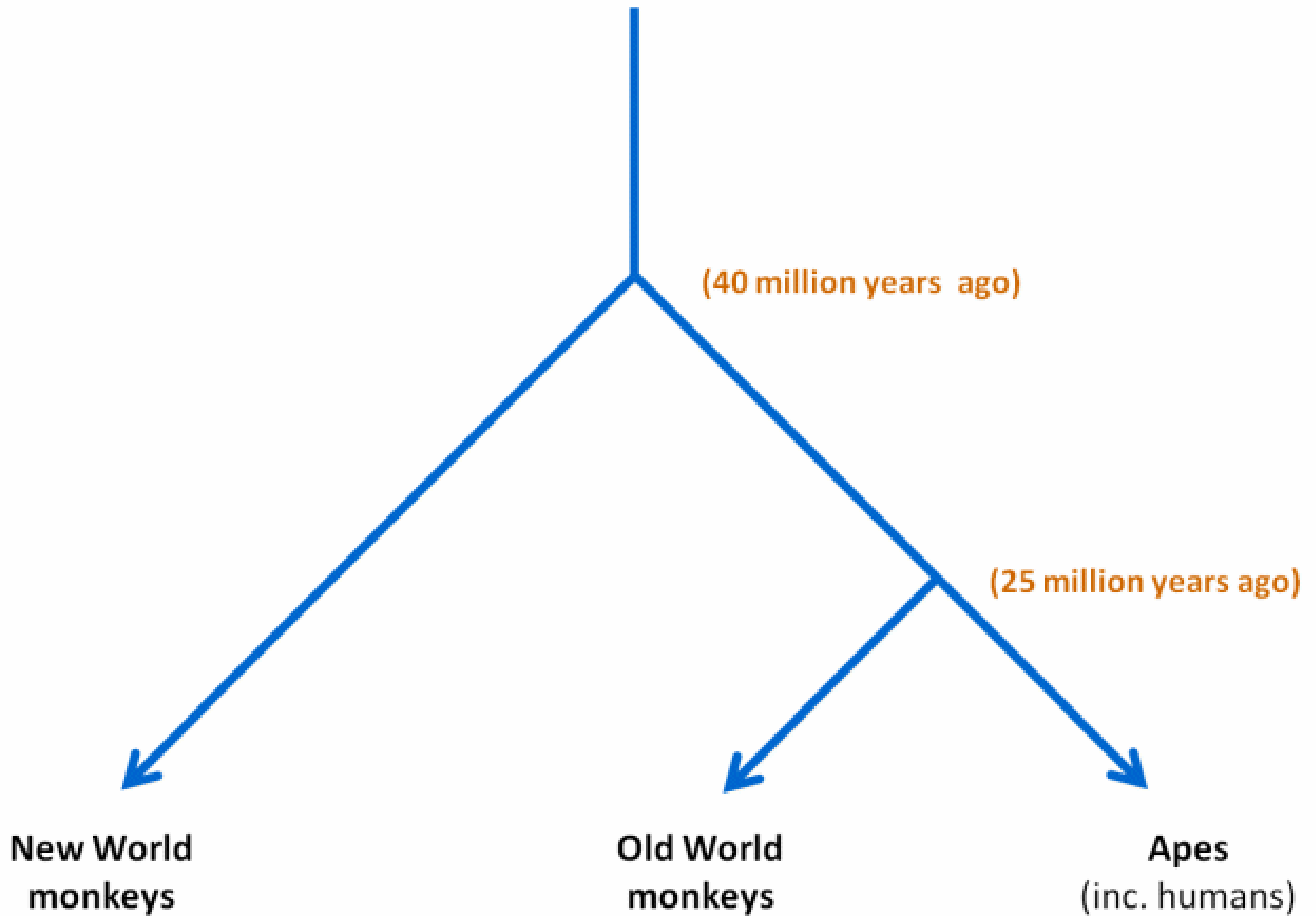
Chimpanzees and Proto-hominids Divergence

Australopithecus and Homo Divergence

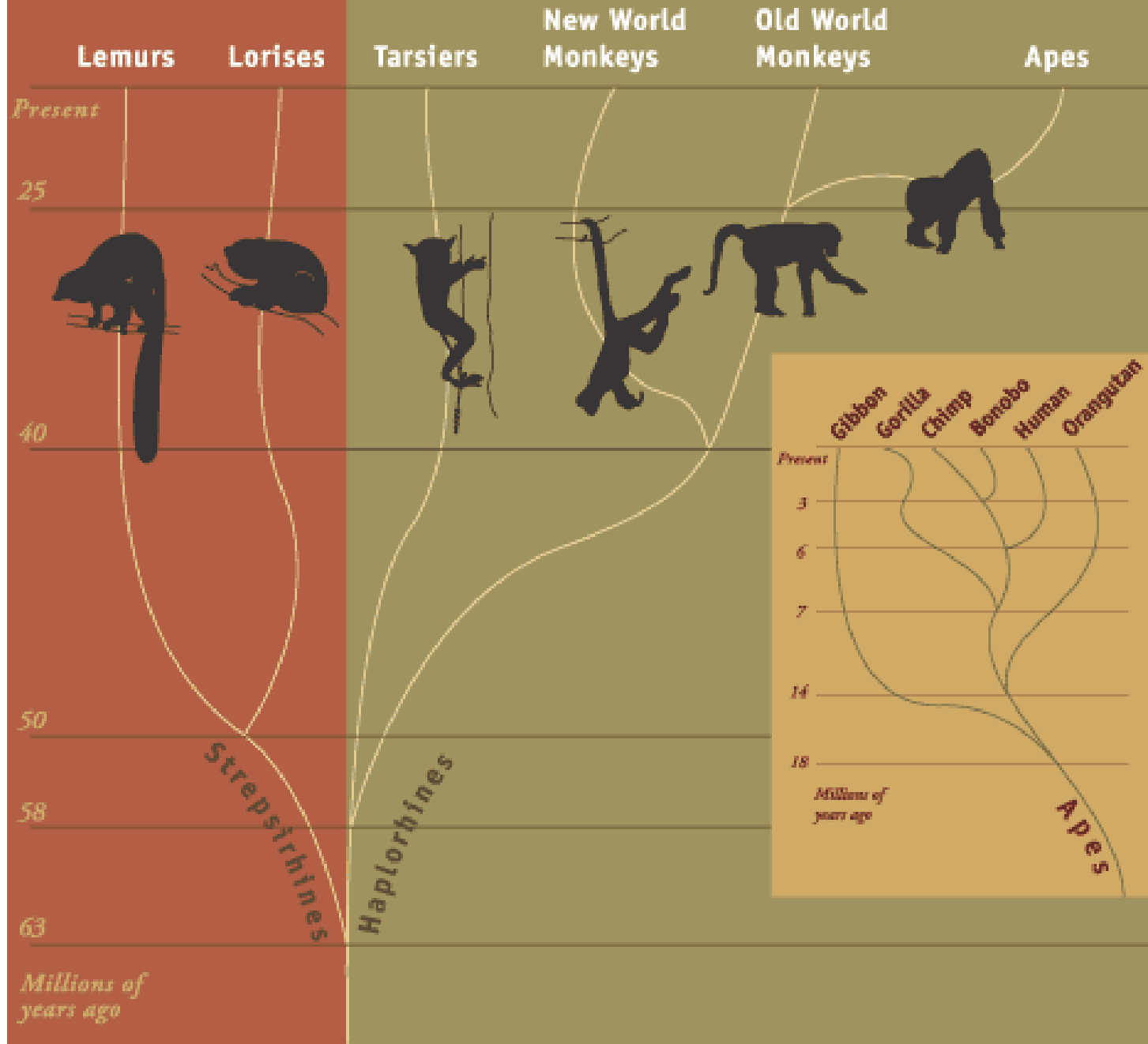


The Prosimians vs The Anthropoids

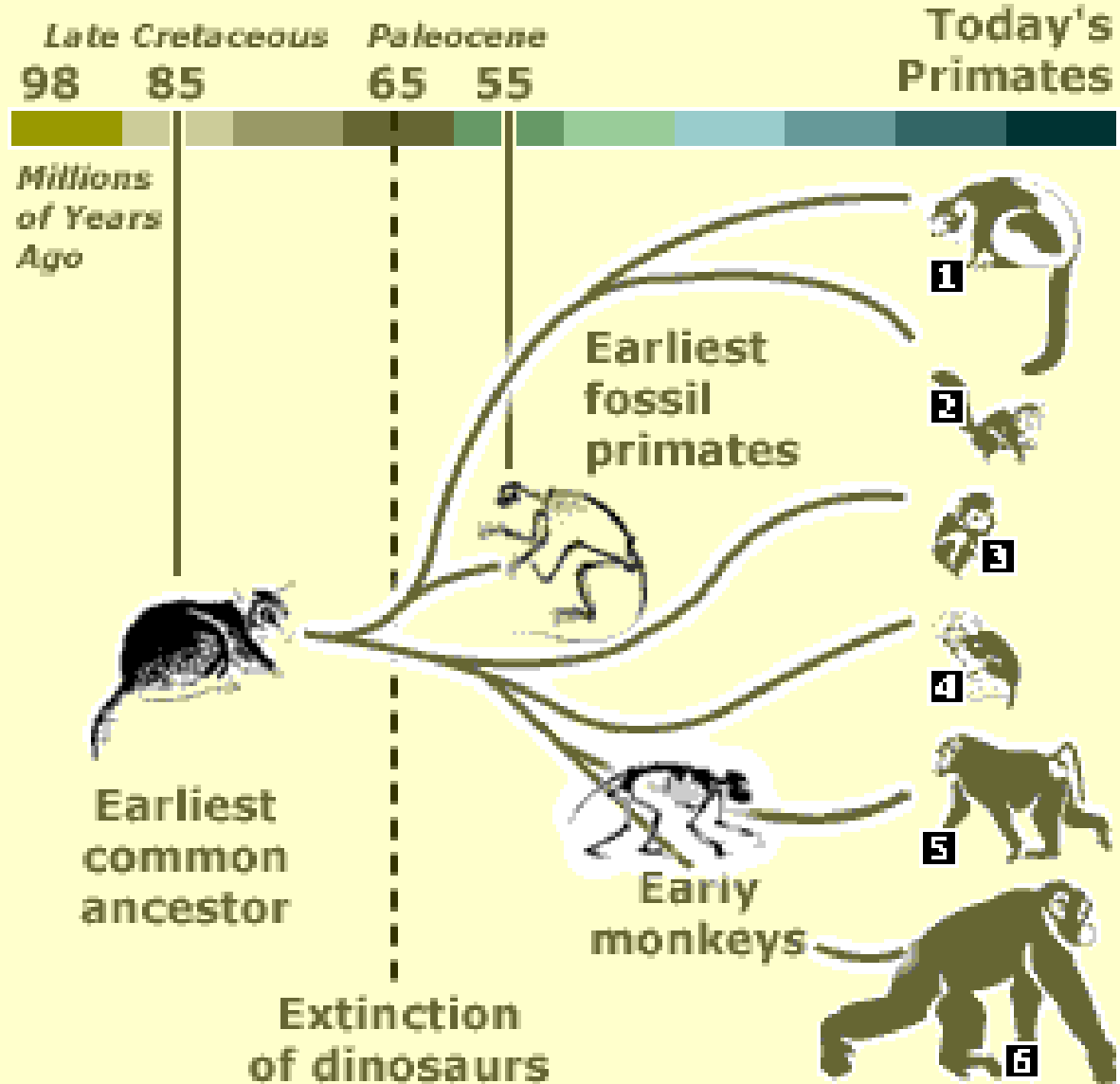
- The two major groups of primates are the prosimians, or lesser primates, and the anthropoids, or higher primates.
- Prosimians retain a variety of primitive features, such as a rhinarium and an olfactory bulb. In addition, they often retain claws and their fingers are less dexterous than other primates. Prosimians have more specialized diets than other primates and are nocturnal. They also possess some derived features, such as the dental comb. The major primates within the prosimians are the lorises, lemurs, tarsiers, and galagos.
- Anthropoids possess numerous derived traits, including a larger brain, more sexual dimorphism in body size, fewer teeth, and nails instead of claws. They have also lost the rhinarium and developed color vision, both of which reflect their increased reliance on vision. Anthropoids tend to be more omnivorous and the majority of them are diurnal. **Anthropoids include New World monkeys, Old World monkeys, apes, and humans.**



THE PRIMATE FAMILY TREE

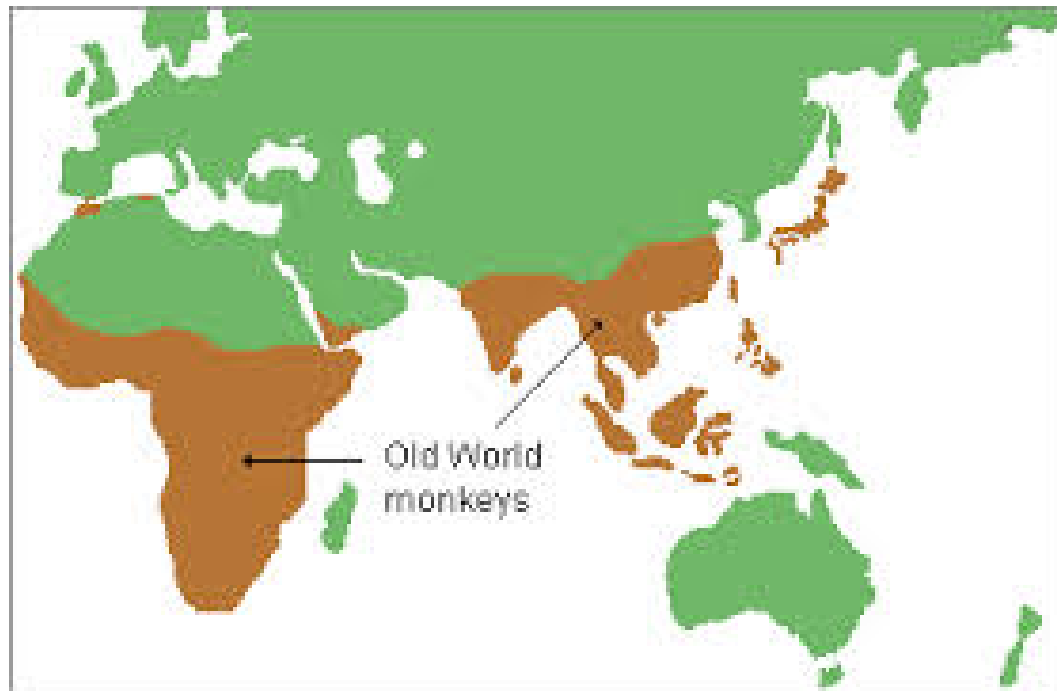


New evolutionary tree for primates



KEY: 1. Lemurs 2. Lorises 3. Tarsiers 4. New World monkeys 5. Old World monkeys 6. Apes & humans

Range of New World and Old World Monkeys



ANTHROPOIDS

2. Anthropoids = monkeys + apes + man

Monkeys:

- Old world monkeys
- New world monkeys

New World
Monkey:

Flat face

Wide nostrils

Prehensile tail



Old World
Monkey:

Long snout

Close nostrils

Non-prehensile
tail

Why Different?

- There are several major differences between Old World and New World monkeys but 4 in particular.
- Nostrils – New World Monkeys have nostrils that flare out. Platyrrhini means “flat nose”. Where Old World monkeys flare down.



Size

- New World monkeys tend to be smaller than Old World monkeys. They range from a few ounces (Pygmy Marmoset) to around 30 pounds (Howler monkeys).



Why Different?

- New World monkeys lack the butt pad that Old World Monkeys have.
- Due to lack of terrestrial living and New World monkey are primarily monogamous, no need of butt pad for attracting mates.

Baboon (Old World Monkey) Butt Pad



OLD WORLD

Narrow , downward pointing nostrils.

Longer hind legs than forearms.

Flattened nails on fingers and toes.

Prominent buttock pads.

Tails, but not prehensile.

Medium-large size.



NEW WORLD

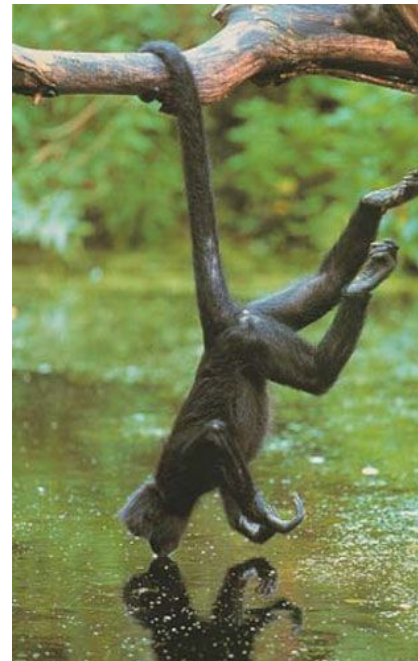
Wide, spaced apart, circular nostrils .

Small to medium sized.

Long tails , sometimes prehensile.

No buttock pads.

No cheek pouches





Old World Monkey

Surprising similarity

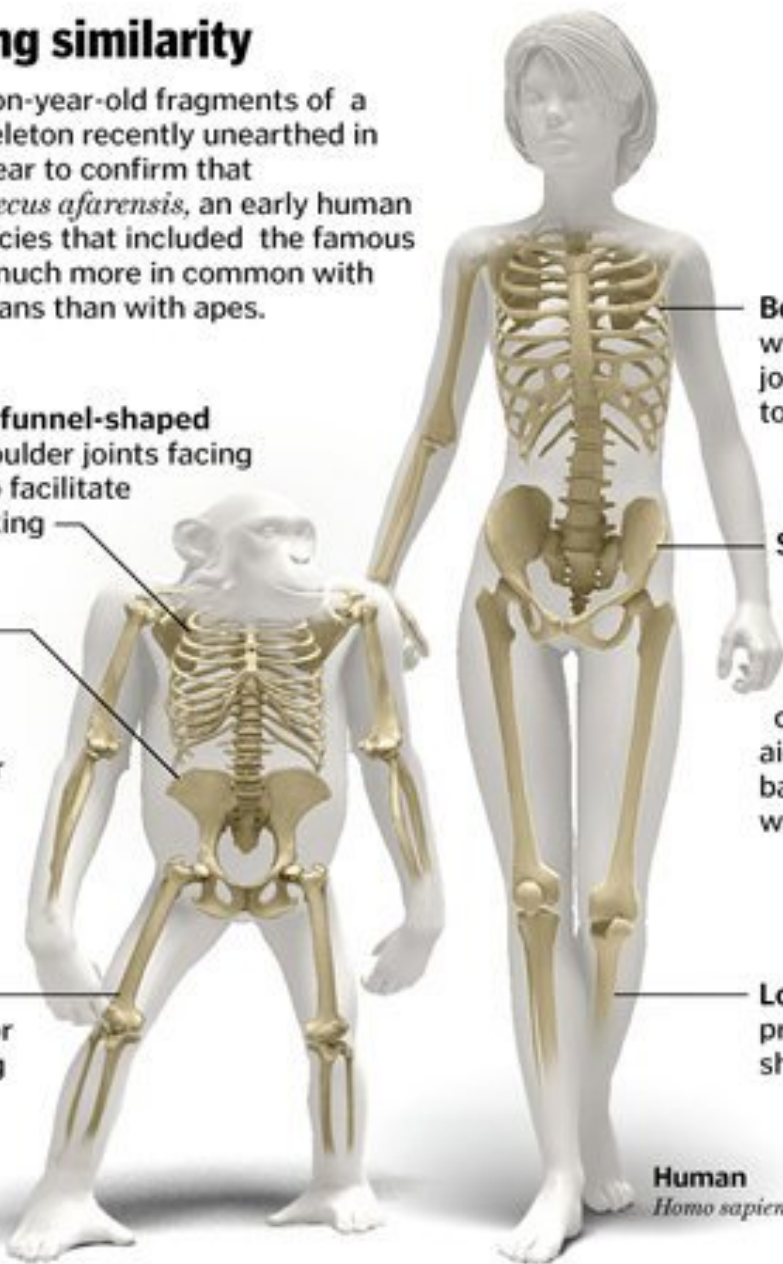
The 3.6 million-year-old fragments of a fossilized skeleton recently unearthed in Ethiopia appear to confirm that *Australopithecus afarensis*, an early human ancestor species that included the famous "Lucy," had much more in common with modern humans than with apes.

Pyramid- or funnel-shaped rib cage, shoulder joints facing downward to facilitate knuckle-walking

Tall pelvis with hip bones close together, locking lower vertebrae to stiffen the back

Short legs, long arms for tree-climbing

Chimpanzee
Pan troglodytes



Human
Homo sapiens

Kadanuumuu
Australopithecus afarensis



5 to 5.5 ft.

Box rib cage with shoulder joints pointed to the side

Short, wide pelvis, with lower vertebrae free to curve, aiding balance while walking

Long legs and proportionately shorter arms

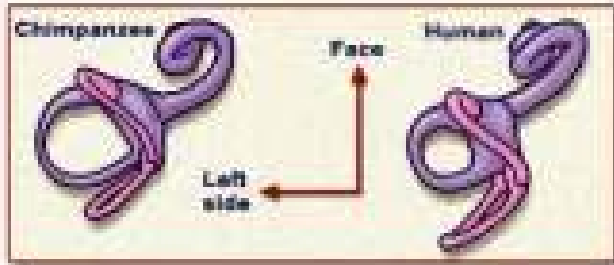
Recovered pieces of skeleton

Kadanuumuu's is about as complete as Lucy's — 30 to 40 percent — but the particular pieces are more revealing

Elbows like ours — not adapted for swinging from tree branches

3.5 ft.

Lucy
Australopithecus afarensis



Gluteus medius

Gluteus minimus

Gluteus maximus

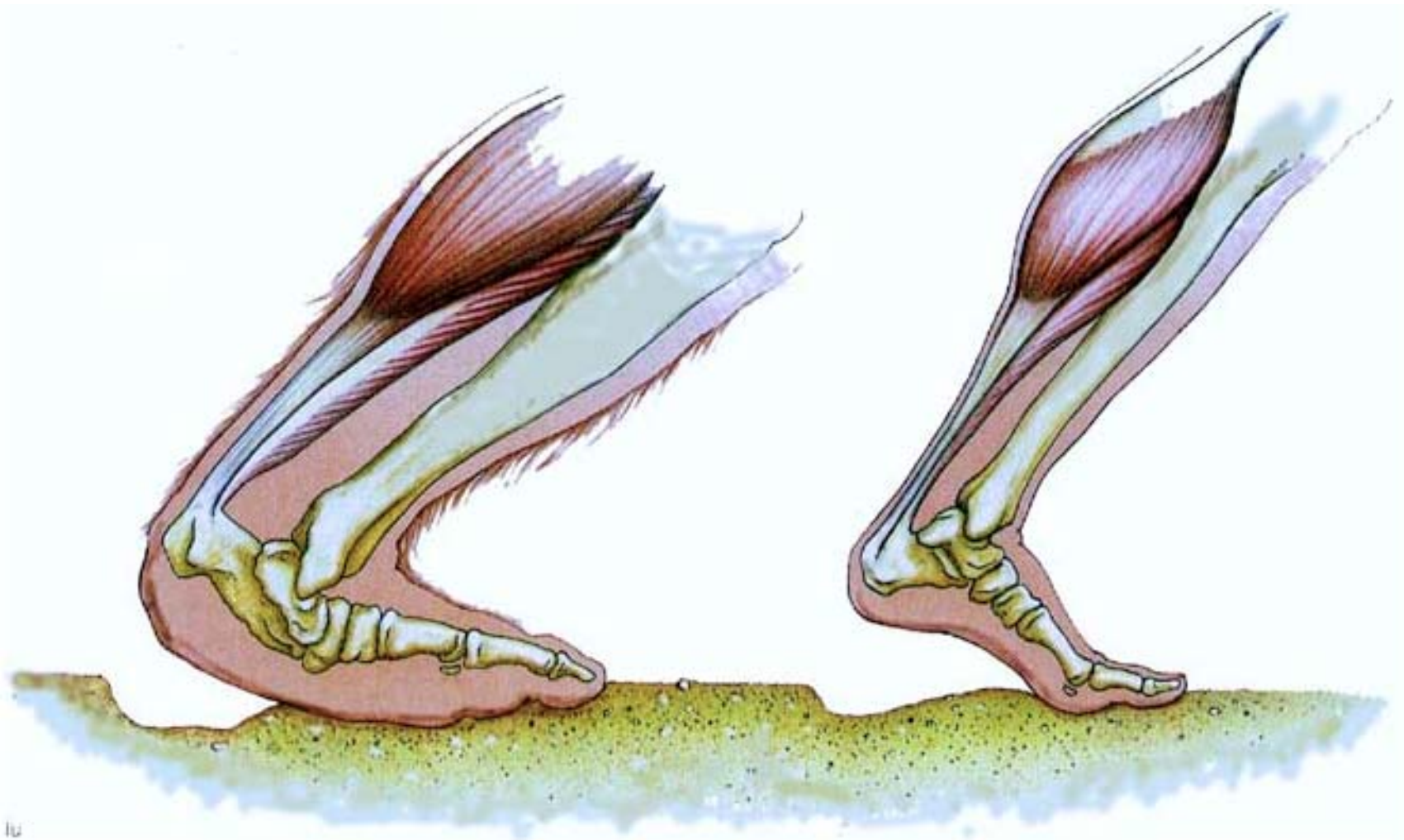


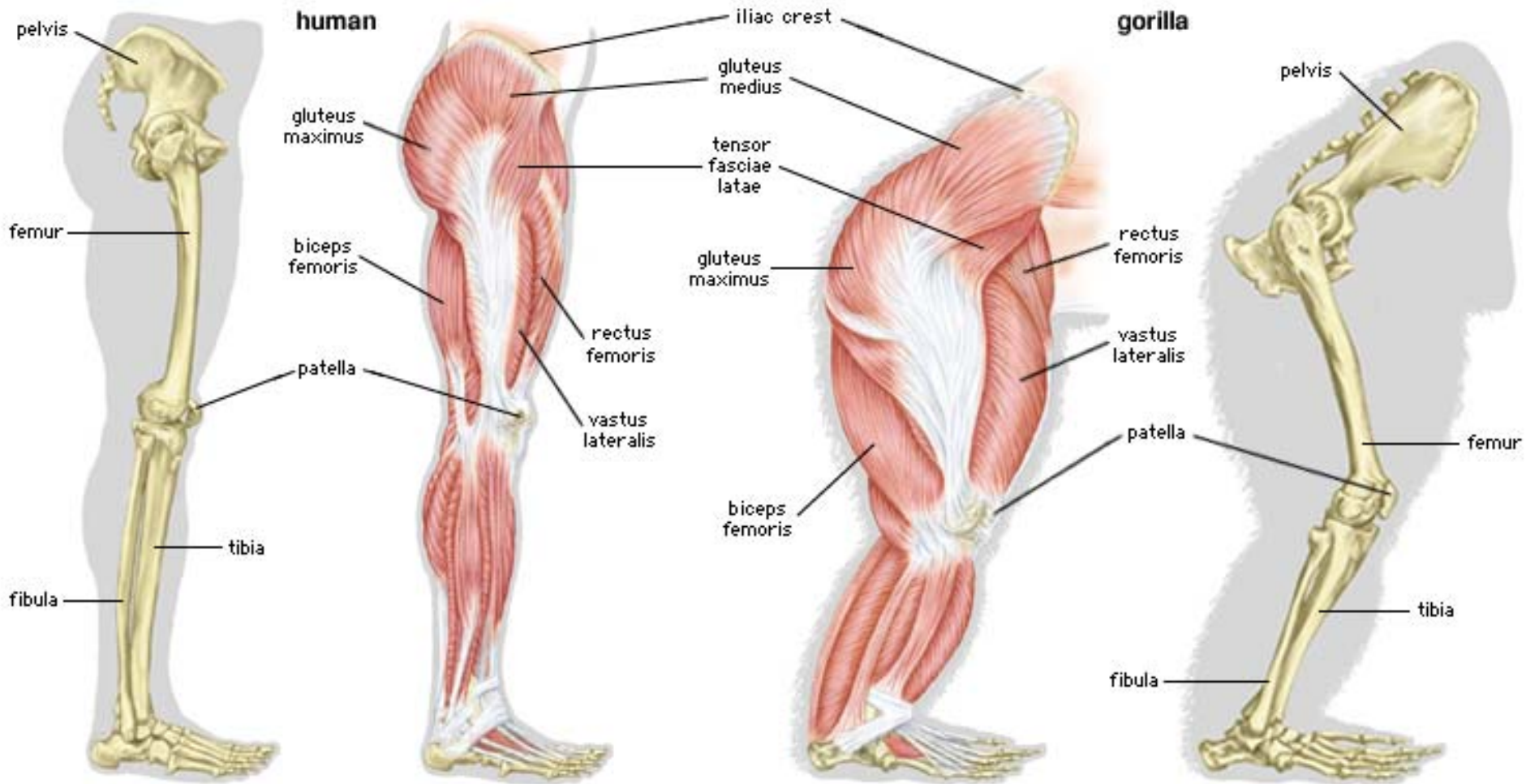
Gluteus medius

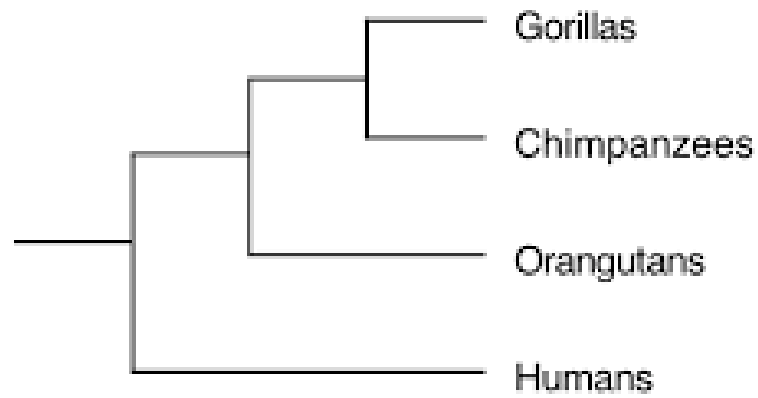
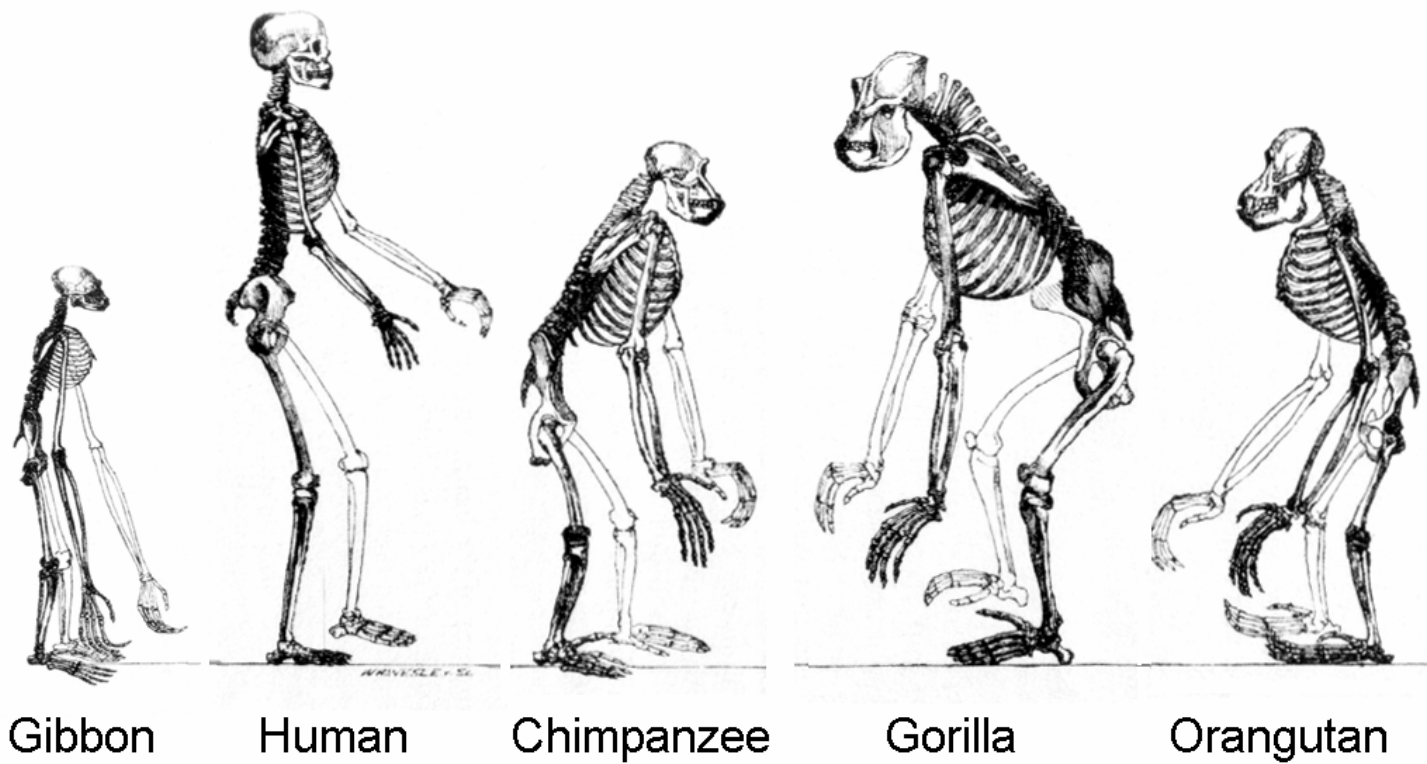
Gluteus minimus

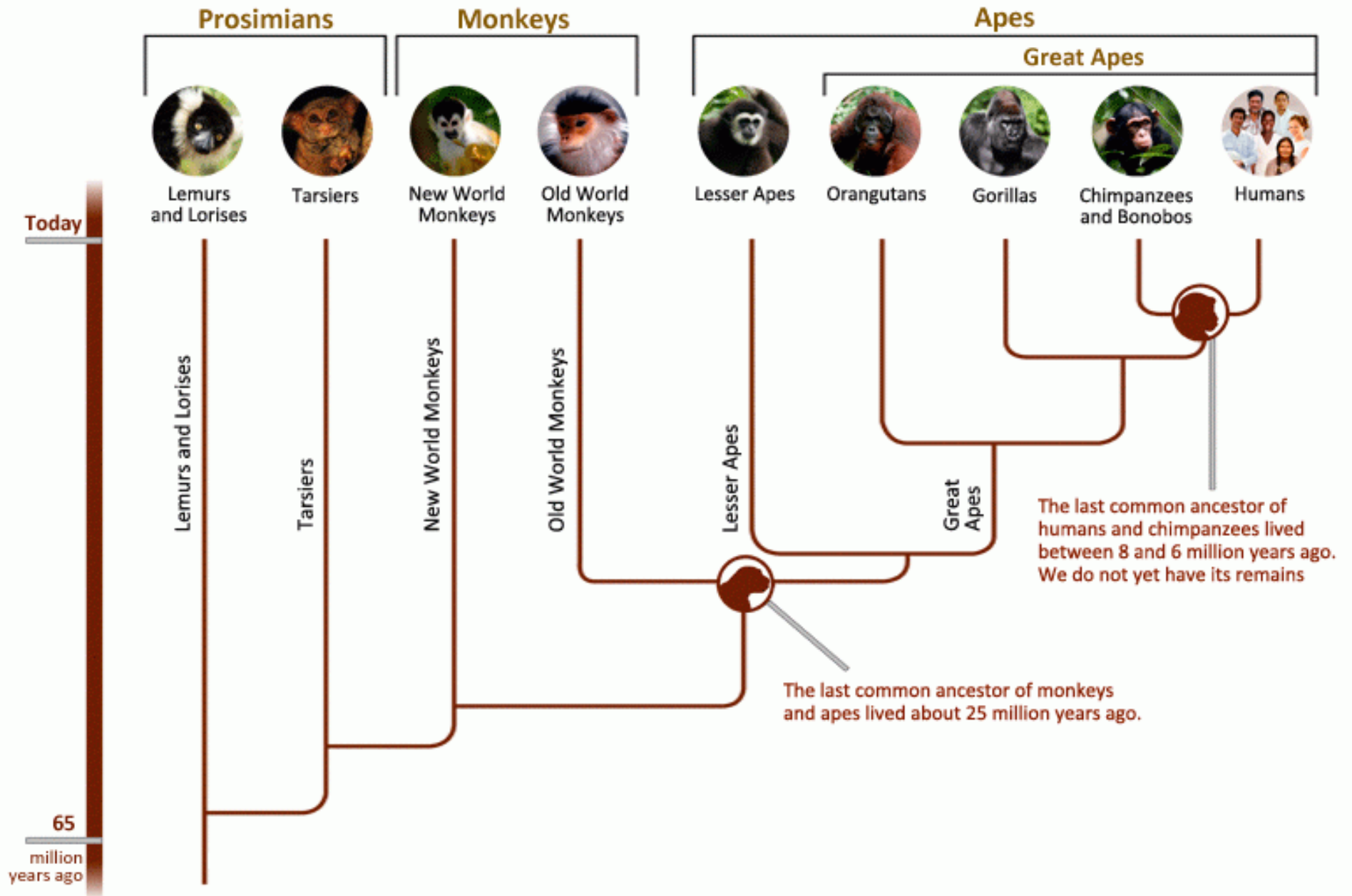
Gluteus maximus

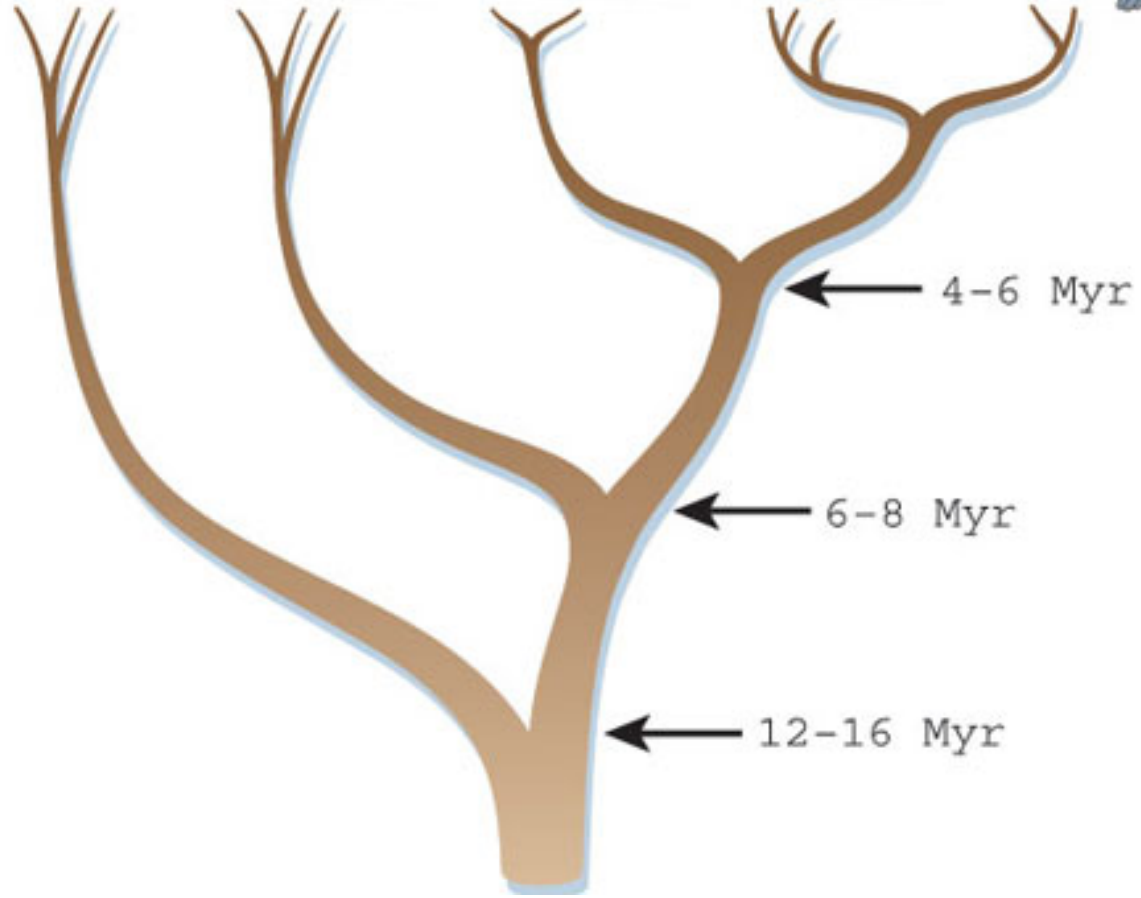
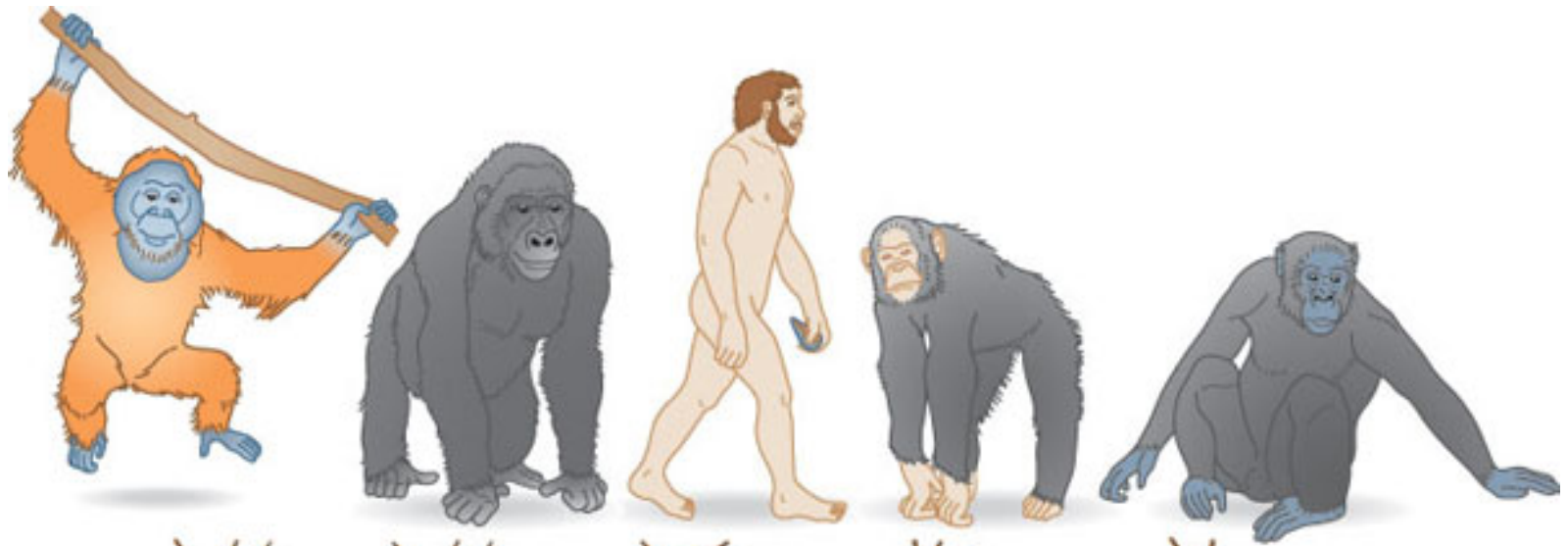


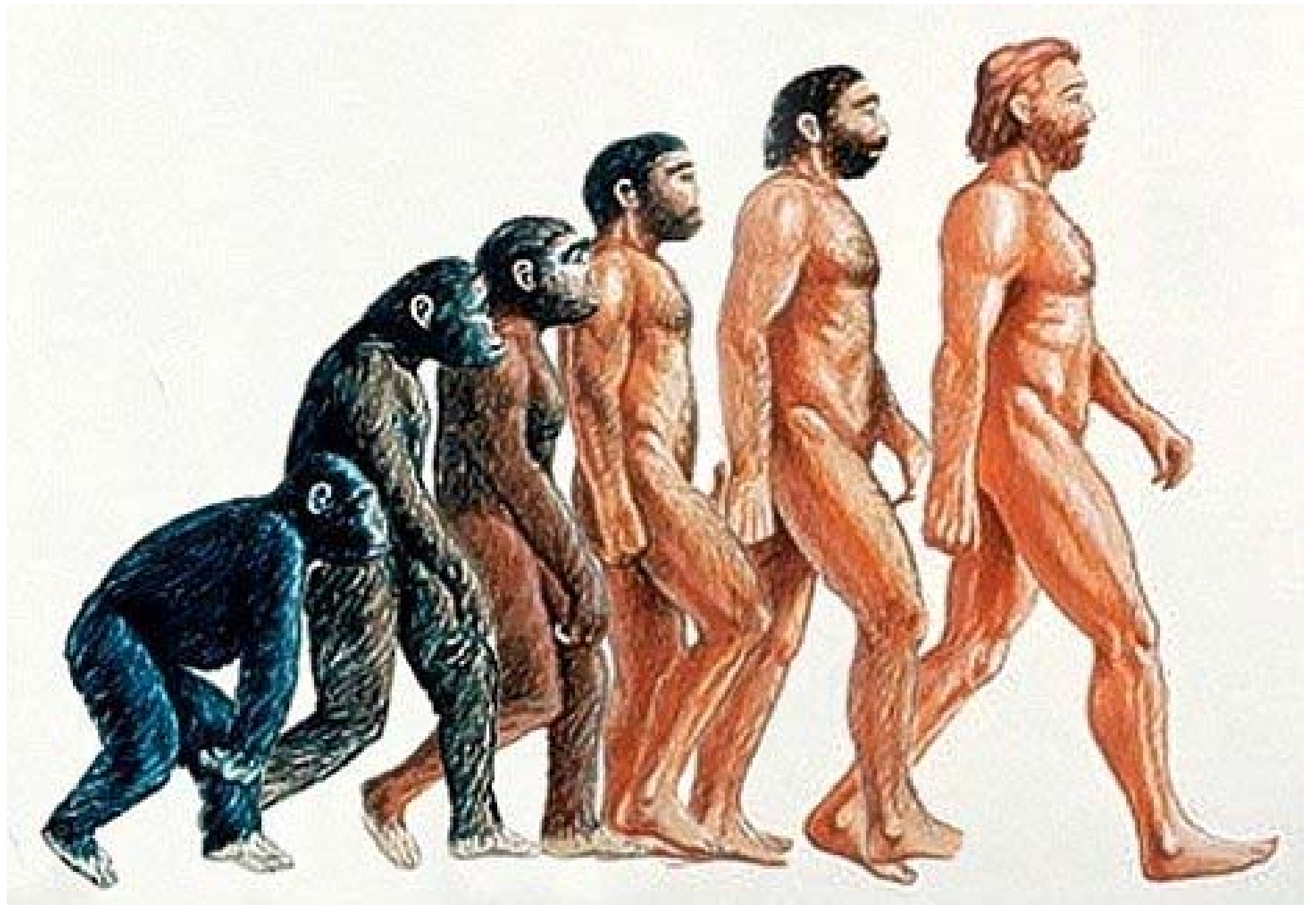












Great Apes & Humans

- We are the Great Apes' relatives; separated by 7 to 6 million years of evolution and by less than 2% of our chromosomal DNA.
- If we compare ourselves to all other forms of life, will we see ourselves as being more like or more different than our Great Ape relatives ?
- What is the difference between physical and behavioral evolution?

























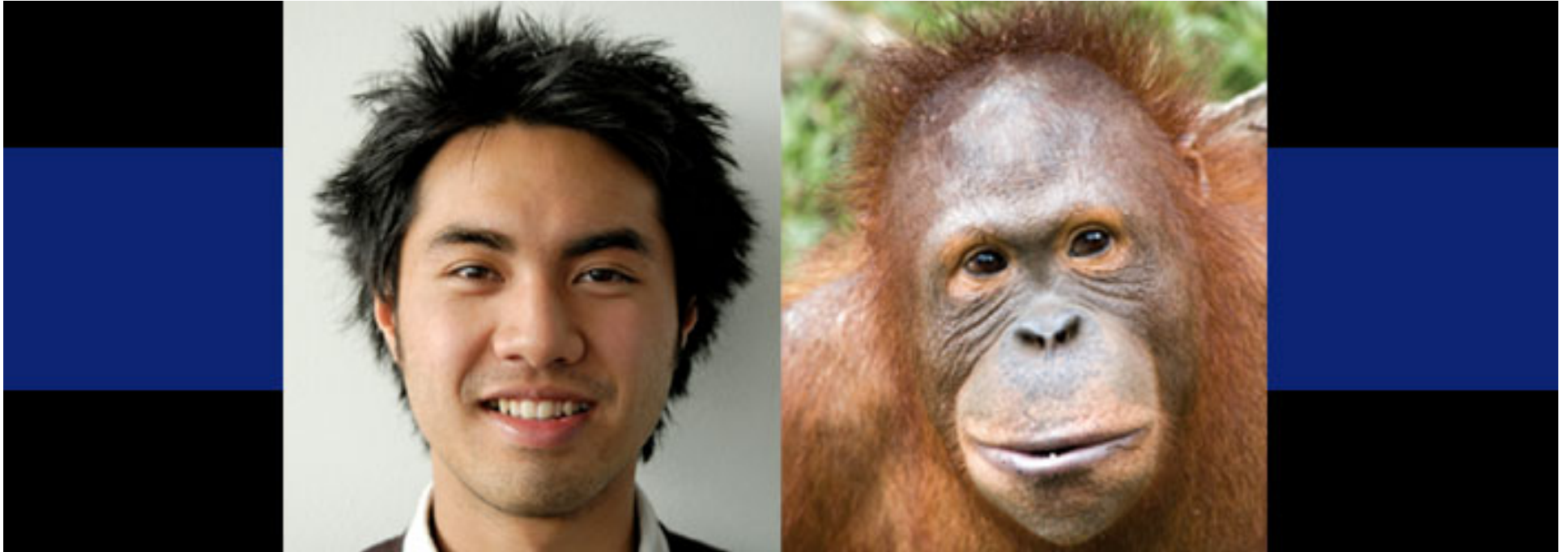










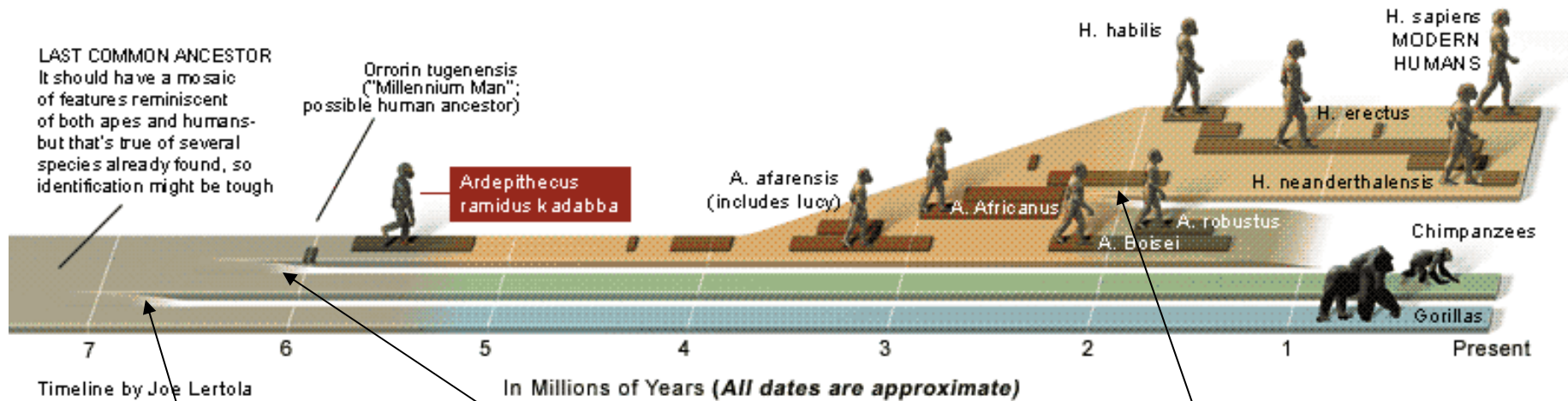


We share more physical and behavioral traits with our Great Ape relatives than with any other form of life!

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Gorillas and Chimpanzees Divergence

Chimpanzees and Proto-hominids Divergence

Australopithecus and Homo Divergence



Understanding Evolution

your one-stop source for information on evolution

To learn more about evolution visit this Web site *created by the University of California Museum of Paleontology with support provided by the National Science Foundation (grant no. 0096613) and the Howard Hughes Medical Institute (grant no. 51003439).* // <http://evolution.berkeley.edu/evolibrary/home.php>