Human Evolution (A Great Lesson Supplement)
Curriculum Guide

Materials: TimeLine Scroll
The Great Lesson Story (The Story of Humans)
Human Evolution Card Set

Prerequisites: Students should have a good understanding of the concept of time and time notation. Ideally, students should be familiar with the BC/AD timeline. Students should have some familiarity with the Great Lessons (Coming of the Earth & Universe, Coming of Life, & Coming of Humans).

Overview:

The Human Evolution Cards have been designed in a "Who Am I" format which allows for use with or without the Time Line Scroll. Each card set can be self-checked. The story of the Human Evolution card set is updated with current findings and within the current prevailing theoretical model. The story begins with the last common ancestor, Sahelanthropus tchadensis, and ends with Homo sapiens. The theory on Human Evolution is a wonderful lesson as it allows students to develop a better understanding of the scientific method and the historical and cultural nature of all scientific investigations.

The artistic rendition of these early human species was a challenging process. From the fossil evidence, our artist was able to render each species on paper. There are many images that you can find online and they vary from artist to artist. This could be a topic of conversation with students.

Included with this curriculum guide is a basic overview of human evolution, important concepts and vocabulary.

Please Note:

- *The information presented above is a compilation of basic information on human evolution from multiple sources online. This information was summarized to provide a basic background on the theory of evolution, basic concepts, and vocabulary only.*
- *All dates used in this product are estimates and based upon multiple sources.*
- *All images used in this product are artistic renditions of the scientific knowledge on early human species. All of these images are copyright protected and the exclusive property of Clocca Concepts. No reproductions are allowed. If you have any questions concerning these images, please contact info@cloccaconcetps.com.*

Presentation: Building a TimeLine

1. Begin with an overview on the Great Lesson Story of the Coming of Humans. Please refer to your teacher's manual. Online resources are available.
2. Lead a discussion on the theory of human evolution (background notes are contained within the Curriculum Guide). Make sure to discuss (1) the history of human's investigation of his origins, (2) fossil evidence, (3) the naming and

classification of early human species, and (4) important developments in the brain, pelvis, hands, and feet, (5) tool development.

3. Scale the timeline for use with the Human Evolution card set. We recommend the following scale: (a Black Line Master is available to use for scale cards)

   5 tick marks = 100,000 years

4. After the TimeLine Scroll has been scaled, read the story (back of card or you can use your own story) and have students match the card with the correct description card and date card. Place the card down on the approximate tick mark on the TimeLine.
5. After completing, gather cards, roll up the scroll and return to the shelf.

Supplemental Activities:

1. Have students match up species descriptions with the correct species.
2. Have students complete the Human Evolution Species Research Report and provide a more detailed description on one or more early human species.
3. Have students compare the cranial capacities of different species by measuring cubic centimeters in a container.
4. Have students investigate the differences and similarities between primates and early human species (bones, cranial capacity, culture, language, etc...)

Background & Notes:

What is human evolution?

Human evolution is a scientific theory of the origins of the human species, *Homo sapiens. Homo sapiens* share clear anatomical, genetic, and historic relationships to other primates. Of all primates, humans bear particularly close affinity to other members of a group known as hominoids, or apes, which includes orangutans, gibbons, gorillas, chimpanzees, and humans. Humans and their immediate ancestors, known as hominids (but more recently noted as hominins), are notable among hominoids for their bipedal locomotion, slow rate of maturation, large brain size, and, at least among the more recent hominids, the development of a relatively sophisticated capacity for language, tool use, and social activity.

Bipedalism

Bipedalism is the basic adaption of the ***Hominin*** line and is considered the main cause behind a suite of skeletal changes shared by all bipedal hominins. The earliest bipedal Hominin is considered to be either ***Sahelanthropus*** or ***Orrorin***. There are several theories of the adaptation value of bipedalism. It is possible that bipedalism was favored because it freed up the hands for reaching and carrying food, saved energy during locomotion, enabled long distance running and hunting, or helped avoid hyperthermia by reducing the surface area exposed to direct sun.

Anatomically the evolution of bipedalism has been accompanied by a large number of skeletal changes, not just to the legs and pelvis, but also to the vertebral column, feet and ankles, and skull. Perhaps the most significant changes are in the pelvic region, where the long downwards facing iliac blade was shortened and became wide as a requirement for keeping the center of gravity stable while walking. The shortening and narrowing of the pelvis evolved as a requirement for bipedalism and had significant effects on the process of human birth which is much more difficult in modern humans than in other primates. The femur evolved into a slightly more angular position to move the center of gravity towards the geometric center of the body. The knee and ankle joints became increasingly robust to better support increased weight. Also in order to support the increased weight on each vertebra in the upright position the human vertebral column became S-shaped and the lumbar vertebrae became shorter and wider. In the feet the big toe moved into alignment with the other toes to help in forward locomotion. The arms and forearms shortened relative to the legs making it easier to run. The foramen magnum migrated under and more anterior to the skull.

Encephalization

The human species developed a much larger brain than that of other primates – typically 1,330 cc (cubic centimeters) in modern humans, over twice the size of that of a chimpanzee or gorilla. The pattern of encephalization started with *Homo habilis* which at approximately 600 cc had a brain slightly larger than chimpanzees, and continued with *Homo erectus* (800-1100 cc), and reached a maximum in Neanderthals with an average size of (1200-1900cc), larger even than *Homo sapiens*. The increase in volume over time has affected different areas within the brain unequally - the temporal lobes, which contain centers for language processing have increased disproportionately, as has the prefrontal cortex which has been related to complex decision making and moderating social behavior. Encephalization has been tied to an increasing emphasis on meat in the diet and it has been proposed that intelligence increased as a response to an increased necessity for solving social problems as human society became more complex.

Sexual dimorphism

Sexual dimorphism is a phenotypic difference between males and females of the same species. Examples of such differences include differences in morphology, size, ornamentation and behavior. The reduced degree of sexual dimorphism is primarily visible in the reduction of the male, the reduced brow ridges and the general robustness of males. ***Another important physiological change related to sexuality in humans was the evolution of hidden estrus. Humans are the only ape in which the female is fertile year round, and in which no special signals of fertility are produced by the body.* Nonetheless humans retain a degree of sexual dimorphism in the distribution of body hair and subcutaneous fat, and in the overall size, males being around 25% larger than females.

Other changes

A number of other changes have also characterized the evolution of humans, among them an increased importance on vision rather than smell; loss of body hair; evolution of sweat glands; a change in the shape of the dental arcade from being u-shaped to being parabolic; development of a chin (only found in *Homo sapiens*), development of styloid processes; development of a descended larynx.

The Beginnings of a Theory on Human Evolution

Before Darwin

The word *homo*, the name of the biological genus to which humans belong, is Latin for "human". It was chosen originally by Carl Linnaeus in his classification system. The word "human" is derived from the Latin word, *humanus*, and the adjectival form of *homo*. Linnaeus and other scientists of his time also considered the great apes to be the closest relatives of humans due to morphological and anatomical similarities.

Darwin

The possibility of linking humans with earlier apes by descent only became clear after 1859 with the publication of Charles Darwin's *On the Origin of Species*. Darwin argued for the idea of the evolution of new species from earlier ones. Darwin's book did not address the question of human evolution, saying only that "Light will be thrown on the origin of man and his history".

The first debates about the nature of human evolution arose between Thomas Huxley and Richard Owen. Huxley argued for human evolution from apes by illustrating many of the similarities and differences between humans and apes, and did so particularly in his 1863 book *Evidence as to Man's Place in Nature*. This idea was not welcomed by most scientists and created much debate around the world.

First fossils

There was very little fossil evidence in the late 1800's to support the idea of human evolution. Despite the 1891 discovery by Eugène Dubois of what is now called Homo erectus at Trinil, Java, it was only in the 1920s when such fossils were discovered in Africa, that an intermediate species began to take shape. In 1925 Raymond Dart described *Australopithecus africanus*. The type specimen was the Taung Child, an Australopithecine infant which was discovered in a cave. The child's remains were a remarkably well-preserved tiny skull and an endocranial cast of the brain. Although the brain was small (410 cm^3), its shape was rounded, unlike that of chimpanzees and gorillas, and more like a modern human brain. Also, the specimen showed short canine teeth, and the position of the foramen magnum was evidence of bipedal locomotion. All of these traits convinced Dart that the Taung baby was a bipedal human ancestor, a transitional form between apes and humans.

The East African Fossils

During the 1960s and 1970s hundreds of fossils were found, particularly in East Africa in the regions of the Olduvai Gorge and Lake Turkana. The driving force of the east African research was the Leakey family, with Louis Leakey and his wife Mary Leakey, and later their son Richard and daughter in-law Meave being among the most successful fossil hunters and paleoanthropologists. From the fossil beds of Olduvai and Lake Turkana they amassed fossils of Australopithecines, early Homo species, and even Homo erectus. These finds cemented Africa as the cradle of human kind. In the 1980s Ethiopia emerged as the new hot spot of paleoanthropology as "Lucy", the most complete fossil member of the species Australopithecus afarensis, was found by Don Johanson in Hadar in the Middle Awash region of northern Ethiopia. This area would be the location of many new hominin fossils particularly those uncovered by the teams of Tim White in the 1990s, such as *Ardipithecus ramidus*.

The scramble for the earliest Human

In the 1990s several teams of paleoanthropologists were working throughout Africa looking for evidence of the earliest divergence of the Hominin lineage from the great apes. In 1994 Meave Leakey discovered *Australopithecus anamensis*, but the find was overshadowed by the news of Tim White's discovery of *Ardipithecus ramidus*, which pushed back the fossil record to 4.2 million years ago. In 2000 ,Martin Pickford and Brigitte Senut discovered a 6 million years old bipedal hominin in the Tugen Hills of Kenya, which they named Orrorin tugenensis. And in 2001 a team lead by Michel Brunet discovered the skull of *Sahelanthropus tchadensis* which was dated as 7.2 million years ago, and which Brunet argued was a bipedal, and therefore a hominin.

A Theory Emerges on Human Migration

Anthropologists in the 1980s were divided regarding some details of reproductive barriers and migratory dispersals of the *Homo* genus. Subsequently, genetics has been used to investigate and resolve these issues.

The Out-of-Africa model proposed that modern *H. sapiens* originated in Africa recently (approx. 200,000 years ago) and their subsequent migration through Eurasia resulted in complete replacement of other *Homo* species. This model has been developed by Chris Stringer and Peter Andrews.

In contrast, the multiregional hypothesis proposed that *Homo* genus contained only a single interconnected population like it does today (not separate species), and that its evolution took place worldwide continuously over the last couple million years. This model was proposed in 1988 by Milford H. Wolpoff.

There are still differing theories on whether there was a single exodus or several.

What does the evidence say?

The evidence on which scientific accounts of human evolution is based comes from many fields of natural science. The main source of knowledge about the human evolutionary process has traditionally been dependent on the fossil record, but since the development

of genetics , DNA analyses have provided much insight. The studies of ontogeny, phylogeny and especially evolutionary developmental biology of both vertebrates and invertebrates offer considerable insight into the evolution of all life, including how humans evolved. The specific study of the origin and life of humans is anthropology, particularly paleoanthropology which focuses on the study of human prehistory.

The earliest fossils that have been proposed as members of the hominin lineage are *Sahelanthropus tchadensis* dating from 7 million years ago, and *Orrorin tugenensis* dating from 5.7 million years ago and *Ardipithecus kadabba* dating to 5.6 million years ago. Each of these has been argued to be a bipedal ancestor of later hominins, but in each case the claims have been contested. The question of the relation between these early fossil species and the hominin lineage is still to be resolved.

From these early species, the Australopithecines arose around 4 million years ago diverged into robust (also called Paranthropus) and gracile branches, one of which (possibly *A. garhi*) probably went on to become ancestors of the genus *Homo*. The australopithecine species that are best represented in the fossil record is Australopithecus Afarensis with more than a hundred fossil individuals represented, found from Northern Ethiopia (such as the famous "Lucy), to Kenya, and South Africa. Fossils of robust australopithecines such as *A. robustus* and *A. boisei* are particularly abundant in South Africa at sites such as Kromdraai and Swartkrans, and around Lake Turkana in Kenya.

The earliest members of the genus *Homo* are *Homo habilis,* which evolved around 2.3 million years ago. *Homo habilis* is the first species for which we have positive evidence of use of stone tools. They developed the **Oldowan** lithic technology, named after the Olduvai Gorge where the first specimens were found. Some scientists consider Homo rudolfensis, a group larger bodied group of fossils with similar morphology to the original *H. habilis* fossils to be a separate species while others consider them to be part of *H. habilis* - simply representing species internal variation, or perhaps even sexual dimorphism. The brains of these early hominins were about the same size as that of a chimpanzee, and their main adaptation was bipedalism as an adaptation to terrestrial living.

During the next million years a process of encephalization began, and with the arrival of *Homo erectus* in the fossil record, cranial capacity had doubled. *Homo erectus* was the first of the hominins to leave Africa, and these species spread through Africa, Asia, and Europe between 1.3 to 1.8 million years ago. One population of *H. erectus*, also sometimes classified as a separate species Homo ergaster, stayed in Africa and evolved into *Homo sapiens*. It is believed that these species were the first to use fire and complex tools. These descendants of African *H. erectus* spread through Eurasia from 500,000 years ago evolving into *H. antecessor*, *H. heidelbergensis* and *H. neanderthalensis*. The earliest fossils of anatomically modern humans are from the Middle Paleolithic, about 200,000 years ago such as the Omo remains of Ethiopia, later fossils from Skhul in Israel and Southern Europe begin around 90,000 years ago.

As modern humans spread out from Africa they encountered other hominins such as *Homo neanderthalensis* . The nature of interaction between early humans and these sister species

has been a long standing source of controversy, the question being whether humans replaced these earlier species or whether they were in fact similar enough to interbreed.

This migration out of Africa is estimated to have begun about 70,000 years ago and modern humans subsequently spread globally, replacing earlier hominins either through competition or hybridization. They inhabited Eurasia and Oceania by 40,000 years ago, and the Americas by at least 14,500 years ago.

Bones, Stone, & Tools

The use of tools has been interpreted as a sign of intelligence, and it has been theorized that tool use may have stimulated certain aspects of human evolution, especially the continued expansion of the human brain.

Precisely when early humans started to use tools is difficult to determine, because the more primitive these tools are (for example, sharp-edged stones) the more difficult it is to decide whether they are natural objects or human artifacts.

Stone Tool Industry

The Oldowan Industry:

The earliest stone tools in the life span of the genus *Homo* are Mode 1 tools, and come from what has been termed the Oldowan Industry, named after the type of site (many sites, actually) found in Olduvai Gorge Tanzania where they have been discovered in large quantities. Oldowan tools were characterized by their simple construction, predominantly using core forms. These cores were river pebbles, or rocks similar to them, that had been struck by a spherical hammer stone to cause conchoidal fractures removing flakes from one surface, creating an edge and often a sharp tip.

The earliest known Oldowan tools yet found date from 2.6 million years ago, during the Lower Paleolithic period, and have been uncovered at Gona in Ethiopia. After this date, the Oldowan Industry subsequently spread throughout much of Africa. *Homo habilis* was the hominin who used the tools for most of the Oldowan in Africa, but at about 1.9-1.8 million years ago Homo erectus inherited them. The Industry flourished in southern and eastern Africa between 2.6 and 1.7 million years ago, but was also spread into Eurasia by travelling bands of *H. erectus*, who took it as far east as Java by 1.8 million years ago and Northern China by 1.6 million years ago

The Acheulean Industry:

Eventually, more complex, Mode 2 tools began to be developed through the Acheulean Industry, named after the site of Saint-Acheul in France. The Acheulean was characterized not by the core, but by the biface, the most notable form of which was the hand axe. These tools first appear in the archaeological record as early as 1.7 million years ago in the West Turkana area of Kenya and contemporaneously in southern Africa.

In contrast to an Oldowan tool, an Acheulean tool is a planned result of a manufacturing process. The manufacturer begins with a blank, either a larger stone or a slab knocked off a

larger rock. From this blank he removes large flakes, to be used as cores. Standing a core on edge on an anvil stone, he hits the exposed edge with centripetal blows of a hard hammer to roughly shape the implement. Then he works it over again, or retouches it, with a soft hammer of wood or bone to produce a tool finely chipped all over consisting of two concave surfaces intersecting in a sharp edge. Such a tool is used for slicing; concussion would destroy the edge and cut the hand.

Some Mode 2 tools are disk-shaped, others ovoid, others leaf-shaped and pointed, and others elongated and pointed at the distal end, with a blunt surface at the proximal end, obviously used for drilling. Mode 2 tools are used for butchering; not being composite (having no haft) they are not very appropriate killing instruments. Mode 2 tools are larger than Oldowan.

The Mousterian Industry

Eventually, the Acheulean in Europe was replaced by a lithic technology known as the Mousterian Industry, which was named after the site of Le Moustier in France, where examples were first uncovered in the 1860s. Evolving from the Acheulean, it adopted the Levallois technique to produce smaller and sharper knife-like tools as well as scrapers. The Mousterian Industry was developed and used primarily by the Neanderthals, a native European and Middle Eastern hominin species.