NOVA

Bones of Contention

Teacher's Guide

OVERVIEW

This activity gives students access to a database that provides information on about 60 fossils of *hominins* (the biological classification consisting of modern humans and chimpanzees), extinct human species, and all our immediate ancestors. For the purposes of comparison, the database also includes eight records of contemporary *hominids*, the biological classification consisting of all modern and extinct Great Apes.

Students can sort and search the fossils by feature, read about what each feature signifies, and use search filters to create groups of fossils with characteristics in common.

Students have these primary tasks:

1. Use the database to classify each of ten mystery fossils by comparing them to fossils of known hominid species. Or, if the fossil is unique, assign it a species name of their choice.
2. Compare and defend their classifications.
3. Revise their findings if necessary.
4. Optional: Compare their findings to the species names given by scientists (to be facilitated by teacher).

Grade Level

This activity is recommended for grades 9–12.

Use the "open-ended inquiry" approach (described below) with more advanced students and the more structured approach with less advanced students.

Suggested Time (including ways to structure for different time frames)

One to three class periods. Students should work in small groups of two or three.

- ***Shorter:*** If you have limited time, each group should receive the Introduction and either Part A, B, or C as a structured investigation. At the end of the activity, students share their findings, using the "jigsaw" method. Then all groups do the Conclusion section.
- ***Medium:*** If you have a little more time, or if your students work quickly, each group should receive the Introduction and either Part A or B as a structured investigation. Groups share their findings for Parts A and B, using the

"jigsaw" method. Then all students do Part C and the Conclusion as a more open-ended investigation.

- ***Longer:*** If you have two to three class periods, or if your students work quickly, all students can do the entire activity.

Depending on your preference, you can adopt a more or less structured approach in the classroom.

Structured inquiry

The student guide provides a structured approach to using the database tool, with specific guidance for creating fossil groups, analysis questions, and space for recording data.

Open-ended inquiry

The database tool is ideally suited for open-ended student inquiry.

- Instead of providing the full student guide, give students only the first two levels of headers. For example:
  Part A. Looking at evidence of bipedalism
  1. Group cranial records for earliest fossils based upon foramen magnum position
  2. Group post-cranial records for earliest bipeds
- Provide the analysis questions for each Part.
- As mentioned above, you may wish to give students Parts A and/or B in a more structured format to help them learn to use the database tool. Once they are familiar with the tools, give them the remaining section(s) in a more open-ended format.

Before the Activity

Review ahead of time some general information about early hominins, such as those belonging to the genera *Australopithecus, Paranthropus, Homo*, and pre-*Australopithecines,* such as *Ardipithecus, Orrorin, and Sahelanthropus.*

"Fossil Evidence of Bipedalism"

Show students this supporting video segment adapted from NOVA's "Becoming Human." It presents how scientists use the fossil record to trace when early human ancestors (and related species) began walking on two legs and to determine whether their appearance was more apelike or human. It will also introduce them to the concept that there were many similar apelike bipedal species, which as a group, flourished for several million years.

NOVA's "Who's Who in Human Evolution"

http://www.pbs.org/wgbh/nova/beta/evolution/whos-who-human-evolution.html

This clickable illustration of hominin types and their relationships to each other provides an index of key information about the available fossil record for each species. You can review this supporting activity as a refresher and also use it with students as a follow-up to "Classifying Hominim Fossils"

Background Essay

You and your students should read and discuss the included background essay prior to starting the activity. The background essay covers the following key concepts, which you may wish to augment with additional instruction:

- How scientists distinguish human ancestors from ancestors of modern apes. In particular, the significance of bipedalism, diet, and cognitive capacity.
- Principles of biological classification, in particular of hominins.
- That classification of fossils is not always clear-cut and is subject to debate within the scientific community.

Review this Vocabulary list with your students

hominid: The group consisting of all modern and extinct Great Apes (i.e., modern humans, chimpanzees, gorillas and orangutans plus all their immediate ancestors). In formal biological classification, *hominidae* are a *family*.

hominin: The group consisting of modern humans, extinct human species, and all our immediate ancestors (including members of the genera *Homo, Australopithecus, Paranthropus and Ardipithecus*). In formal biological classification, *hominini* are a tribe.

classification: Biological classification, or scientific classification in biology, is a method by which biologists group and categorize organisms by biological type, such as family, tribe, genus, and species.

genus: In biology, a genus (plural: genera) is a taxonomic unit (a taxon) used in the classification of living and fossil organisms. In this activity, we explore several genera within the hominin *family*, such as: *Australopithecus, Paranthropus*, and *Homo*.

species: In biology, a species is a taxonomic unit (a taxon) used in the classification of living and fossil organisms. For instance, within the *genus* Australopithecus, *species* include afarensis, africanus, and garhi. Within the *genus homo, species* include habilis, erectus, and sapiens.

bipedal: Walking on two legs. A defining characteristic of hominins, this refers to having the ability or inclination to walk upright.

cranial: Describing the skull, or more specifically the portion of the skull enclosing the brain. A related term: *post-cranial* refers to all or part of the skeleton apart from the skull.

THE ACTIVITY

Part A. Bipeds: Finding the earliest upright walkers

This section explores the earliest bipeds through separate searches of cranial and post-cranial data. Key fossils include the *pre-Australopithecines (i.e., Sahelanthropus tchadensis, Ardipithecus ramidus, Orrorin tugenensis)* and the *Australopithecines (i.e., A. afarensis, A. africanus, P. aethiopicus)*. Some key species, such as *A. anamensis* and *Orrorin tugenensis* lack foramen magnum and femur data so will likely be excluded from the filtered groups of records that students create within the database.

This first section is highly structured in order to model for students how to use the tool.

Key concepts

- **Bipedalism** is considered the earliest factor differentiating human ancestors from ancestors of modern apes.
- **Cranial vs. Post-cranial.** Scientists refer to cranial fossils, describing the skull, and post-cranial refers to all or part of the skeleton apart from the skull.
- **Analyze both.** Since few fossils have both cranial and post-cranial information, we must explore bipedalism via two separate analyses.
- **Key indicators.** Cranial: Foramen Magnum position (where the spine enters the skull). Post-cranial: shape and position of the pelvis, femur, shinbones and finger bones, relative lengths of the limbs.

Tips and Notes

1. Group cranial fossils for earliest bipeds (foramen magnum position):
    - **Use Filters to refine.** When narrowing down a group, it is helpful to use additional filters to remove obvious outliers. For instance, when filtering for "Foramen Magnum position = back of skull," it helps to create an additional filter for "Date is greater than 0," to filter out contemporary apes. However, be cautious! In some cases over-filtering removes other candidate matches that may be missing one type of data.
    - **Filter: Foramen Magnum Position = Back of Skull.** The first mystery fossil (1) is revealed: Sahelanthropus tchadensis. It is considered by some as the earliest known biped, though this is debated. Even though its foramen magnum is located at the back of the skull, many scientists note that its slightly forward position shows that it was bipedal, the earliest known biped to date. This is a good example of how fossil data are not always clear cut and are often subject to scientific debate!
    - **You may wish to give students the following background on this fossil:** *In fact, scientists gave this fossil the name Sahelanthropus tchadensis. Though its foramen magnum is positioned further toward the back of the skull than more recent bipeds, many scientists note that its slightly forward position shows that it was bipedal, the earliest known biped to date.*

      Still, scientists disagree about precisely where this species falls in our ancestral family tree. Some scientists think Sahelanthropus tchadensis may represent a common ancestor of humans and chimpanzees; others think it could be their relative but not an ancestor; still others question whether it *even belongs to the hominid family tree.*

- **Filter:** Foramen Magnum position = Middle of Skull. This filter includes 30 records, so students need to find another criterion for narrowing the search. In this case, date is helpful. Interesting date cut points are 2 mya, 2.5 mya, and 3 mya.
- **"Greater than" vs. "Greater than or equal to."** Be sure students are aware of the different language in their date filters, as it can make a big difference!
- **Mystery fossil:** 3. Australopithecus afarensis (AL 444-2). Since it is the only A. afarensis in the database that has data on the Foramen Magnum position, students may at first have a hard time assigning it to this species. Instead they may group it with a named relative or give it its own descriptive name. This is okay–it is a part of the investigative process. Later, as they learn more, they may rename this fossil based on additional findings—just as scientists do.

2. Group post-cranial fossils for the earliest bipeds:
   - **Start with Femur.** This produces the best post-cranial evidence of bipedalism. Sorting by femur before creating a filter also makes the non-bipedal records stand out more conspicuously.
   - **Important dates.** Since we are looking for the earliest bipeds, focus on dates prior to 2 mya. Note the earliest fossil with bipedal characteristics is Ardipithecus ramidus (6 mya).
   - **Mystery Fossils:** There are several possible answers. For example, students may associate these fossils with A. afarensis or A. africanus based on other available records. Or, they can give their saved group a descriptive name such as "early bipeds."
   - If they note traits other than bipedalism, such as dentition or tools, they may further differentiate these records into separate groups. However, this is not required or necessarily expected.

Analysis Questions Key

1. **What is the difference between cranial and post-cranial fossils?**
   See vocabulary section.
2. **Based on the available evidence, who do you think was the earliest biped?**
   Some think that the earliest biped is the fossil dated 6–7 mya, known as *Sahelanthropus tchadensis* (though students will not know it's scientific name). This is based on the fact that its foramen magnum position (which is categorized as "back of skull") is nonetheless more forward than most quadrupeds. However, students do not have access to these data, so they are more likely to identify the earliest biped as *Ardipithecus ramidus* (6 mya), based on its angled femur. In either case, students will not know the scientific names since there are no other fossils like them. Instead, students should give them descriptive names based on their key characteristics. For example, names such as "early biped" or "pre-biped" are both okay, given that there is some debate about the earliest bipeds.
5. **What is the earliest sign of large leg bone? Which is the next earliest?**
   First: *Australopithecus afarensis*/AL 288-1/Lucy: 2.9–3.3 mya

Second: *Australopithecus garhi*: 2.5 mya

Again, students may be unable to give the scientific genus/species names of these fossils, so they can answer using the date or other identifying traits.

3. **In addition to femur orientation, which features proved useful in helping you narrow your group(s)? Explain how.**

   The most likely answers will be "largest limb" and "pelvis shape". Other post-cranial data relating to bipedalism, such as shinbones and fingers, have limited data in this date range.

4. **Are their any mystery fossils in your groups of cranial and post-cranial bipeds that might be the same species? If so, explain your reasoning?**

   Students could make a case for grouping AL 288-1/Lucy: 2.9–3.3 mya from the post-cranial bipeds with AL 444-2, based on their bipedalism and close dates. In fact, those are both *A. afarensis.* The next closest mystery relative is *A. garhi*: 2.5 mya.

Part B. Diet: How chewing affects the skull

This section explores how diet played key role in the emergence of the *Homo* genus. It is less structured and requires more student decision-making.

Key concepts

- Key indicators. Dentition, cresting, face shape, and post-orbital constriction.
- Harder foods require larger teeth as well as more robust skulls and larger faces to support massive jaw muscles.
- Some scientists think that a diet based on eating softer foods is a possible catalyst for cognitive development, as less robust skulls may have allowed for more brain growth.

Tips & Notes

1. Filter for "Cresting = Large"
   - Further filtering the "large crests" group by dentition (megadontia denotes the largest molars) or "face shape" (dish-like faces) produces similar results, and identifies all of the "robust" Australopithecine species (also known as Paranthropus), with one outlier: Sahelanthropus tchadensis, which can be removed with a date filter, along with contemporary Apes.
   - Mystery Fossil: 6. *Paranthropus boisei* (KNM ER 732). Students should be able to group this fossil in the *Paranthropus* genus and might be able to identify it as *P. boisei* based on date.
   - The *Paranthropus* genus is thought to be an extinct branch of the human family tree that shared a common *Australopithecus* ancestor with humans.

2. Filter for "Cresting = none"
   - "Cresting = none" produces fossils mostly from the *Homo* genus.
   - The goal here is to find the earliest hominins with a soft diet, so further filter for "Dentition = small molars." (Note that this also removes some *Homo erectus*.)
   - Further filtering to get rid of outliers might include removing fossils with Date greater than 0.
   - To find the earliest fossils with signs of a soft diet, you could sort by date.

But it is also worth noting that "face shape" produces a valid subgroup. Another valid data point is post-orbital constriction, though there are not as many data for that and therefore this filter may remove some valid matches from the saved group.

- Mystery Fossil: 5. *Homo habilis* (KNM-ER 1813). Students should be able to identify this as a *H. habilis*, or possibly *H. rudolfensis*, based on cresting, molars, and date.

Analysis Questions Key

1. **Describe what cranial features can tell us about a hominin's diet.**
   Larger teeth indicate harder foods. Larger crests, longer faces, and extreme post-orbital constriction of modern Apes and early hominins help support the powerful jaw muscles required to consume hard diets. Smaller teeth and less robust cranial structures indicate a softer diet.
2. **Why is diet significant? What can it tell us about a species?**
   This is an interpretation question. Diet is important for several reasons. Any of the responses below is a valid answer.
   a) It can tell us how species adapted to a changing environment. For instance, the development of larger chewing complex in *Paranthropus* (robustus) species may have allowed them to consume a greater variety of plants. Development of smaller chewing complexes suggest the incorporation of meat into a softer diet and an adaptation to a more diverse diet.
   b) Meat provides more calories and proteins, enhancing survival and also provides more energy to support brain development.
   c) A diet that includes meat could suggest greater social organization. In scavenging omnivores, meat is hard to come by and perhaps required some degree of non-meat food sharing when meat was unavailable. In hunting omnivores, social organization would have been necessary for successful hunting and for food sharing when hunts were unsuccessful.
   Teacher Note: Earlier meat eaters (omnivores) likely scavenged, whereas later omnivores hunted. This is indicated by sophisticated tools (see next section).
3. **Looking over the groups you created, what are the differences in cranial capacity between groups with hard diets versus those with a less robust chewing complex? (You may need to show the column for "Cranial Capacity".)** Describe this relationship.
   As cranial capacity increases, cresting decreases, post-orbital constriction decreases, and faces flatten. In general, smaller more robust skull features correlate to smaller cranial capacities. For instance, post-orbital constriction means less room for brain.

   Some scientists think that the diminishing robustness of skull features that came with softer diets may have allowed for the development of larger brains in more modern hominins. Other scientists think the reverse: that larger brains led to more expanded craniums (e.g., less post-orbital constriction). Regardless of causality, these features are linked to brain development over the course of evolution. Diet-related features are of primary significance in differentiating the *Homo* genus from *Australopithecus* and

Paranthropus.

4. **Compare the dates of the groups you created based on diet, particularly those with a hard diet and the earlier species with a soft diet. Do you notice any overlap in when they lived? What does this tell you about the relationship between these species?**
   Note that *P. boisei* and H. habilis are essentially contemporaries. There is a key branching happening here in the family tree, with two branches of *Australopithecine* descendants: *Paranthropus* (robstus) and *Homo*. Diet-related features are of primary significance in differentiating the *Homo* genus from *Australopithecus* and *Paranthropus*.

Part C. Brain size and Cognitive Ability

This section focuses primarily on cranial capacity and tool use to differentiate species within the *Homo* genus. It is also the least structured, as by now students should have a good feel for how to use the database tool.

Key Concepts

- Key indicators of cognitive ability. Cranial capacity, post-orbital constriction, brow size and cresting. However, brain size is not always a precise indicator of evolutionary advancement.
- Another important indicator of cognitive ability is the use of tools. As hominins got smarter, their tools became more sophisticated. Likewise, increased tool use probably supported hunting of meat and the grinding of plant products, thus providing energy needed to support larger brains.

Tips & Notes

- Cranial capacity is a primary differentiator of species in the *Homo* genus, but it can be deceptive. Pay close attention to fossils of children versus adults.
- Post-orbital constriction is an important indicator of intelligence. Not only does it affect cranial capacity, it also particularly affects the frontal lobe, which has been associated with abstract thought and higher reasoning.
- Data on tools represents a characterization of tool types that are most closely associated with the fossil, according to the date and location of the tools and the fossils found. It does not necessarily mean that a particular type of tool was found with that given fossil.
- Mystery fossils: 7. *Homo ergaster/erectus* (KNM-WT-15000), 8. *Homo erectus* (Sinanthropus), 9. *Homo sapiens* (Petralona), 10. *H. neanderthalensis* (La Chapelle). Interesting note: the *H. sapiens* fossil predates the *Neanderthal* fossil by more than 100,000 years!

Analysis Questions Key

1. **What role do cresting and post-orbital constriction have in determining brain size?**
   Crests are used for muscle attachments. These are especially prominent in small-skulled species where there is not enough room for muscle to attach. In these cases, the crests help small skulls support large muscles. Large muscles in the skull region are usually for consuming hard foods or for

holding up heavy faces. In this way, large crests correlate with smaller brain sizes. Post-orbital constriction is the narrowing of the skull right behind the eyes. When the constriction is extreme, brain size is small (especially in the frontal lobe, which has been associated with abstract thought and higher reasoning). As the post-orbital constriction is reduced, frontal brain size is increased.

2. **According to this database, what is the earliest species to use tools? What makes this fossil similar or different from others like it?**
   This is a mystery fossil, *A. garhi,* noted by a date of 2.5 mya. Students may have identified it in Part A of this activity. It is like an *Australopithecus* in most ways except for its longer legs (in relation to arms) and its postulated use of tools. (This fossil is noted by scientists as a potential link between *A. afarensis* and *H. habilis*.)
3. **Who were the earliest users of symmetrical tools? What else do you notice about species that used symmetrical tools?**
   H. erectus/ergaster. Note the jump in cranial capacity found among species that used symmetrical tools. Unlike asymmetrical tools, symmetrical tools lend themselves to hunting.
4. **Provide an explanation for the rapid growth in brain size in the most recent human ancestors.**
   This is an interpretive question, and students may answer in different ways. Scientists think that as diet changed, so did the need to support huge jaw muscles. With this came the growth in cranial capacity, associated with brain size. Larger brains require more energy. Meat provides the energy necessary to support brain development. Increased cognitive capacity leads to the development of more sophisticated tools, eventually giving rise to hunting. Likewise, more hunting means increased meat consumption (see above). In other words, “the smarter get smarter.”
5. **Why is cranial capacity a deceptive indicator of evolutionary advancement?**
   While cranial capacity is an indicator of brain size and larger brains are required for advanced cognition, there is not a direct relationship between brain size and intelligence. Examining the fossil record shows a great degree of variation across fossils of different species. Brain size also can be linked to body size (larger individuals often have larger brains) and to the age of the specimen at death, which is not always known. Some scientists note that the particular area of brain development can impact cognitive capacity (i.e., the frontal lobe is associated with abstract though, the development of which is connected to post-orbital constriction. Furthermore, factors other than brain size can determine the evolutionary fate of a species. Note for instance that *Homo neanderthalensis* had as large (if not larger) cranial capacities as *Homo sapiens*, yet many scientists think that they were eventually replaced by more adaptable *Homo sapiens.* (See “Out of Africa Theory.”)
6. **Taking it Further: Though the purpose of the nasal margin is unclear, it is a clear species differentiator. Describe how it helps differentiate species.**
   Among the *Homo* fossils, only *H. erectus/ergaster/antecessor* specimens appear to have a smooth nasal margin. (The exception to this is a lone *H. sapiens* mystery fossil with a date of 150,000–250,000.) By contrast, a *H.*

habilis fossil (OH 24) and *H. rudolfensis* fossil (KNM-ER 1470), two species that are closely associated, have sharp nasal margins like more modern *H. neanderthalensis* and *H. sapiens*. Interestingly, *H. habilis* and *H. rudolfensis* are often thought to be the earliest known species of the genus *Homo*, predating many known *H. erectus* fossils.

The purpose of the change in nasal margin is unclear, though it is controlled by genetics and changes throughout human evolution. This is a derived trait (new term alert!), meaning it just appeared in the most recent ancestor – the one that gave rise to a newly formed branch. It is also a good differentiator because:
a) It seems to be independent of brain size
b) It is not on a continuum. (The margin is either smooth or sharp, and there is no argument over cutoff points.)
c) It is not changeable throughout an individual's life (i.e., it is under tight genetic control).

Conclusion. Refine Classifications of Mystery Fossils
In this section, students revisit their mystery fossil classifications, applying their knowledge of bipedalism, diet, and cognitive ability to refine their groupings.

At the end of the activity, consider sharing the scientific names of each fossil with students and discussing the challenges of classification.

Key discussion point: Even now, scientists often disagree on how to classify fossils. Why might this be so?

Tips & Notes

- Certain fossils, such as *Sahelanthropus tchadensis* (6-7 mya) and *A. garhi* (BOU-VP-12, 2.5 mya) are the only known fossils for their species and therefore have no direct matches in the database. Students will likely need to give them their own descriptive names.
  a) In the case of *Sahelanthropus*, students might group it with other pre-*Australopithecine* species such as *Ardipithecus* or *Orrorin tugenensis.*
  b) In the case of *A. garhi*, they might match the genus *Australopithecus*. To separate it from other *Australopithecus* species, students might note A. garhi's presumed use of tools.
- If students are to match the two *A. afarensis* fossils, they will need to combine cranial and post-cranial data, since these two records have very different available data. Students might find similarities between these species and other *Australopithecus* records.
- Students might be tricked by the dates of the mystery fossils *H. neanderthalensis* (La Chapelle, 40,000 ya) and *H. sapiens* (Petralona, 150,000-250,000 ya), presuming, incorrectly, that all *H. sapiens* fossils should post-date *H. neanderthalensis* fossils.

INDEX OF MYSTERY FOSSILS

Below is a list of fossils whose identities are “hidden” in the database. The dates will help you sort out which is which—though remember that date can be a misleading criteria for students (and scientists) to use when grouping fossils.

1. *Sahelanthropus tchadensis*: 6-7 mya
2. *A. afarensis* (AL 288-1): 2.9-3.3 mya (Lucy)
3. *A. afarensis* (AL 444-2): 3 mya
4. *A. garhi* (BOU-VP-12): 2.5 mya
5. *H. habilis* (KNM-ER 1813): 1.8 mya
6. *P. boisei* (KNM-ER 732): 1.7 mya
7. *H. ergaster/erectus* (KNM-WT-15000): 1.51–1.56 mya
8. *H. erectus* (Sinanthropus): 220,000-580,000 ya
9. *H. sapiens* (Petralona): 150,000-250,000 ya
10. *H. neanderthalensis* (La Chapelle): 40,000 ya

Note: Students are not expected to be able to give each of these fossils scientific names, since some records are unique and have no corresponding matches in the database. They will identify mystery fossils as they proceed through the activity and have a final opportunity to revise and refine their classifications at the end of the activity, using their knowledge of the full range of fossil characteristics to make their determinations.

ASSESSMENT

Assessment Strategies

Evaluate Analysis Questions

Each of the activity’s three main sections (Parts A, B, and C) ends with for to five analysis questions. Have students record their answers on a separate sheet of paper. Use the answers and notes in this document to evaluate student responses.

Evaluate Mystery Fossil Classifications

Students should record the names of the mystery fossils as they work. In Part D, they have an opportunity to revise and refine their classifications in a master list. Evaluate how well they use evidence to support their classifications, keeping in mind the following:

- The goal is not to record the “correct” scientific classification—few will be able to do that. Rather, the aim is to use the data to justify an informed theory of how the fossil should be classified.
- Scientific names are less important for these purposes than using descriptive terms that demonstrate understanding, such as “small-brained omnivore.” However, using scientific names when possible is desirable.
- Look for differences between students’ initial classifications and their revised (final) classifications. Good explanations for any changes made demonstrate valuable insight and learning.

Evaluate Printouts of Saved Fossil Groups

You can collect lists of students’ “saved groups,” either printed on paper or by having students “print to PDF” and e-mail you the files (if your computers support this). Use the “saved groups” to evaluate how well students are able to identify similar fossils using multiple filters. How they named their groups can indicate how well they understood the filtering they did.

Evaluate Understanding of Key Vocabulary Terms

Use the Key Vocabulary list in this document to evaluate students’ grasp of the key terms related to classification, the hominid family tree, and fossil features.

Standards Addressed in this Activity

Key Curriculum Concepts

- Biological Classification, Evolutionary Classification
- Evolution of Primates and Hominids

National Science Education Standards (1996)

- Life Science, Content Standard C, Grades 9-12.
- http://www.nap.edu/openbook.php?record_id=4962&page=181
- Subarea: “Biological Evolution.”
- http://www.nap.edu/openbook.php?record_id=4962&page=185
- Biological classifications are based on how organisms are related. Organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. Species is the most fundamental unit of classification.
- Example: Fossil comparison Activity: http://www.nap.edu/openbook.php?record_id=4962&page=182
- “Science as Inquiry” Standards:
- http://www.nap.edu/openbook.php?isbn=0309053269&page=105

AAAS Science Standards

- 6. Human Organism, A. Human Identity: http://www.project2061.org/publications/bsl/online/index.php?chapter=6#A4
- 5. Living Environment, F. Evolution of Life: http://www.project2061.org/publications/bsl/online/index.php?chapter=5#F4
- 1. Nature of Science, B. Scientific Inquiry: http://www.project2061.org/publications/bsl/online/index.php?chapter=1#B4

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