# Science Assessment System Through Course Task

## Horsing Around

**Grade Level:**
8

**Phenomena:**
Fossil Evidence for Evolution

**Science & Engineering Practices:**
Analyzing and Interpreting Data
Constructing Explanations and Designing Solutions

**Crosscutting Concepts:**
Cause and Effect

Designed and revised by Kentucky Department of Education staff
in collaboration with teachers from Kentucky schools and districts.

# Preparing to implement Through Course Tasks in the Classroom

**What is a TCT?**

- TCTs are 3-dimensional tasks specifically designed to get evidence of student competency in two dimensions, Science and Engineering Processes (SEPs) and Crosscutting Concepts (CCC), untethered from Performance Expectations (PEs)/standards. Tasks are sense-making experiences.
- Tasks are to be used formatively. The goal is for both students and teachers to understand areas of strength and improvement for the SEP(s) and CCC assessed within the task.

**How do I facilitate a Through Course Task (TCT)?**

- TCT facilitation is a collaborative process in which teacher teams calibrate understanding of the expectations of the task and refine strategies to be used during task facilitation.

Before the task:

1. Complete the TCT as a learner – compare understanding of task through the lens of success criteria (identified in the task) in order to understand expectations.
   Success criteria include:
   - What is this task designed to get evidence of?
   - What is the task asking the students to do?
   - What might a student response look like?
2. Identify the phenomenon within the task. Consult resources to assure teacher teams have a deep understanding of associated science concepts.
3. Collaborate to generate, review and refine feedback questions during facilitation.
4. Identify potential "trouble spots" and plan for possible misconceptions.

During the task:

5. Collect defensible evidence of each student's competencies in 3-dimensional sense-making for the task.
6. Ask appropriate feedback questions to support student access and engagement with the task in order to elicit accurate evidence of student capacities.

After the task:

7. Reflect on the task as a collaborative team.
8. Review student work samples to identify areas of strength and areas of need.
9. Determine/plan next steps to move 3-D sense making forward through the strengthening of the use of SEPs and CCCs.

Using the materials included in this packet:

- **Task Annotation:**
  - The task annotation is a teacher guide for using the task in the classroom. Additionally, the annotation gives insight into the thinking of developers and the task overall.

    - Each task has science and engineering practices, disciplinary core ideas, and crosscutting concepts designated with both color and text style:
        - **Science and Engineering Practices**
        - *Disciplinary Core Ideas*
        - Crosscutting Concepts
- **Student Task:** The materials to be used by students to complete the TCT.

# Horsing Around Task Annotation

After **analyzing and interpreting data** about *physiological changes in the prehistoric to modern horse*, **construct an explanation** for the causal relationship between *the environment and the physiological changes naturally selected for in the evolution of the horse*.

**Phenomenon within the task**

Species change due to natural selection as the environment changes. Depending on the species and the environment, the changes over very long spans of time can be quite significant. One way we can support that this phenomenon occurs is by using evidence from the fossil record.

**How the phenomenon relates to DCI**

MS-LS4-A: Collection of fossils and their placement in chronological order is known as the fossil record, which documents the existence, diversity, extinction and change of many life forms throughout the history of life on Earth (MS-LS4-1). Comparison of anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent (MS-LS4-2), showing how populations have changed over time.

MS-LS4-B: Genetic variations among individuals in a population give some individuals an advantage in surviving and reproducing in their environment. This is known as natural selection. It leads to the predominance of certain traits in a population and the suppression of others. (DCI)

MS-LS4-C: Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus the distribution of traits in a population changes. (DCI)

These are foundations for DCI's of HS-LS3.B: Variation of Traits, HS-LS4.B: Natural Selection, and HS-LS4.C: Adaptation.

**What information/data will students use within this task?**

Students will need to have an understanding of the process of natural selection, basic understanding of inheritance, implications of the fossil record and be comfortable with geologic time to be able to develop a strong argument for how the modern horse came to be. Due to need for this prior content understanding, the task seems "content heavy," but this content is foundational to developing sound understanding of life science. The task can provide evidence of a student's ability to develop a scientific argument about a causal relationship, while strengthening their understanding of the process of natural selection. In this task, students are provided with a graphic that illustrates a geologic time scale of the fossil record of horse structure over time and a written description of how the environment changed over time. This information is used as a basis for creating an explanation of what changes in prehistoric to modern horses occurred, why the changes occurred, and how the changes occurred via the process of natural selection.

**Ideas for setting up the task with students**

Prior learning experience making connections between useful inheritable traits/adaptation and an organism's survival in an ecosystem will prove beneficial, allowing all students opportunities to develop basic conceptual understanding of the content. This basic understanding can be used as students support their explanation through causal reasoning. Students will also need content knowledge related to the mechanism of natural selection and basic understanding of inheritance. It is recommend that teachers provide students with experiences that model or illustrate the process of natural selection and promote discourse about how the process causes change in populations.

Here are a couple of options:

- Free, online HHMI (Howard Hughes Medical Institute) natural selection resources aligned to NGSS LS (can be adapted to middle school)

http://www.hhmi.org/biointeractive/search?sort_by=created&redirect=1&&field_biointeractive_topics%5B0%5D=26620&field_bio_curriculum_field_standard_term%5B1%5D=26892

- Online simulations that highlight examples of natural selection and the natural selection process:

https://phet.colorado.edu/en/simulation/legacy/natural-selection - PHET Natural Selection Simulation
http://peppermoths.weebly.com/ - Peppered Moth Simulation

To hook students, consider using some resources that highlight traits/adaptations of modern day horses.

The information that students process can be presented in various ways or a combination of ways as the facilitator sees fit based on the needs of the students. The following is a list of suggested strategies can support students as they engage in the task.

**Graphic and Written Description**

- Students have a graphic that includes a geologic time scale and changes appearing in the fossil record of horse structure over time and a written description of how the environment changed over time.
- This information can be one combined page (diagram and written description together) or two separate pages for students to analyze (one diagram/model page and one page for the written description).
- If using the option of separate pages, students can rotate to different stations to analyze each page or students can be given one page to analyze at a time. The way the information is distributed is for the facilitator to decide based on the needs of students.

**Card Sort Experience**

- An optional card sort is included for students to use to sort and sequence the information in the diagram before seeing it.
- Students can work individually or as collaboratively to sort the information. Once the individuals/groups are satisfied with their card arrangement, students can complete a "gallery walk" and compare similarities and differences in the final sequences in the classroom.
- Differences and similarities in the arrangements can be a whole group discussion. This might be a good time to ask why the changes happened and get student responses before giving students the written description of environmental changes. It is also a good opportunity to ask the students to think about "how" the changes occurred over time. What is the mechanism for the changes?
- After the discussion, give students the one page diagram showing the correct sequence so they can compare it with their sequence and then analyze the information in the diagram on the analysis page.
- After students have analyzed the diagram/model and recorded "what" the changes are for muscles/height, hooves/feet and teeth in the first column of the organizer, the written description of environmental changes should be given to them to read. They should record "why" the changes occurred in the second column of the organizer, matching the environmental changes with the structural changes or adaptations evidenced in the fossil diagram or model in the first column.

- Sort cards with passages from the written description are also included to allow students to match changes in the environment that led to the natural selection of traits in the diagram. Some classrooms may need some of these differentiation opportunities when working with the written description.
- After recording "what" changes/adaptations occurred in the fossil record in the first column and "why" the changes occurred from the written description in the second column on the analysis page, students are ready to complete the third column describing "how" the changes occurred using the mechanism of natural selection.

**Analysis Graphic Organizer and CER Prewrite Organizer**

- It is recommended that students use the analysis graphic organizer to summarize the information from the diagram/model and the written description to assist them in summarizing the information in order to use it in their final explanation.
- Depending on student needs, the first and second columns on the analysis organizer can be completed collaboratively.
- Once the students summarize "what" changes occurred and "why" they occurred, they will probably need support in completing the "how" portion of the organizer where the mechanism of natural selection should be included. Provide support by asking questions to help them connect what they know about natural selection to the information in the task.
- The CER organizer can then be completed using the summary constructed on the analysis organizer and then the final CER. This may seem redundant, but it will allow students to organize their analyzed information in an explanation that follows the CER format and encourage them to add the natural selection mechanism in the reasoning portion of the CER to connect the relationship between the claim and the evidence.

**Intent of the Task for Assessment**

Students are asked to analyze the information provided (environmental changes and structural changes in the horse over time that are well-suited to each environment) and develop an argument for the causal mechanism for the structural changes in the horse. The process of natural selection is a key piece of reasoning for the substantiating the causal mechanism. Thus, because science "content" is an essential component of the causal argument, evidence of student understanding of this fundamental science concept and the ability to explain how it occurs in nature will be evident although this information is not the focus of the task.

The information presented in this task supports the development of a student's understanding of the process of natural selection, and in doing so a teacher is able to get evidence of a student's ability to analyze and interpret data in various forms (infographic, text and photos) while reasoning with the process of natural selection in order to develop a strong scientific argument for a causal

mechanism. If the student does not include the role of natural selection in their explanation, then this omission provides a good opportunity to develop that understanding subsequent to task use.

**Success Criteria**

*Evidence of Learning Desired based on Progression from Appendices*

Analyzing and Interpreting Data

- Use graphical displays to identify temporal relationships.
- Distinguish between causal and correlational relationships.
- Analyze and interpret data to provide evidence for phenomena.

Constructing Explanations and Designing Solutions

- Construct an explanation using models or representations.
- Construct an explanation that includes qualitative or quantitative relationships between variables that predicts and/or describes phenomena.

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural systems.

*Success Criteria*

Student constructs an explanation for the evolution of the horse based on:

- Identifying a causal relationship between the environment and the structural changes in the horse supported by their analysis of the provided data
- Logical reasoning to describe role of natural selection in causing the changes identified by the fossil recordOne model has a title, one has words and one only has labels.
- Students circle Model B

*Possible Student Responses*

As the years have gone by the environments on earth have changed and so have horses. The horses have changed when the environments began to change. So for example, if the environment began changing from having a soft ground of grass to having hard and rough soil then the horses will begin changing and inheriting new traits that will make it easier for the horses to adapt to

their new environment. The horses will start evolving and changing as time goes on and as the environment changes. Many of the horse's traits will begin changing such as their toes becoming hooves and their size of teeth may start increasing.

One of the things that have changed in the horse's physical appearance is their feet. The horses began with having 4 toes on each foot so the horses could walk easily on the soft ground. But then the environment changed to having a hard ground which made the horse's feet start evolving. The horse's feet began changing and future generations started inheriting new traits like having hooves instead of having toes. The hooves made it easier and less painful to walk on the ground.

Another trait that the horses had that started changing was the size of their span of teeth. The horse's span of teeth began increasing in size as the environment began changing. The big reason why the horse's teeth have changed is because of the food that was supplied in the horse's environment. As time went by there was different amounts and different types of food that could be found in the environment. So if the only food that was in the environment was grass then the horses would have to evolve and change and inherit new traits so they can adapt to eating that specific type of food.

Lastly, the environment changed and evolved just like the horses did. The environments have changed just as much as the horses changed and the environments were the main cause and reason for the horse's change in traits. The horses wouldn't have evolved and inherited new traits if it wasn't for the environment changes. The environments have changed from soft ground to hard ground. It could have also changed by having different amounts and different types of food found in the area.

In conclusion, the horses and environments have changed a lot through time. The horses have changed because of the environment and the environment changed because of the weather and because of other natural causes. The horses have inherited many new traits over time and that has made them the horses they are now. Their physical appearances have changed and so has their way of thinking and their way of life has changed. The horses couldn't be able to survive in the habitats and environments they live in without the change in their traits, the horses had to adapt to their environments over time.

**Other information teacher teams might find useful when preparing to use this task in the TCT process**

To hook students, consider using some resources that highlight modern day horses and examples of their selected traits. This can also lead to a discussion about natural selection vs. selective breeding after completing the task. In one administration of the task,

the Triple Crown races of Secretariat were shown and the class discussed traits of racehorses and how the traits make them successful in winning races. (Secretariat was chosen for his degree of stride length and uncommonly large heart.) Students were able to research the unique traits of racehorses and discuss them after the task as an extension to compare traits from selective breeding by humans and those from natural selection). After viewing the races, students were asked their thoughts on what ancient horses may have looked like in comparison to Secretariat and after the discussion, the task was started. Links to the videos used:

https://youtu.be/74Usj3K4oZ0 - Secretariat - Kentucky Derby 1973
https://youtu.be/eV89InWOENc - Secretariat - Preakness Stakes 1973

https://youtu.be/V18ui3Rtjz4 - Secretariat - Belmont Stakes 1973

- In one administration of this task, a class was given the diagram/model and the written description combined on one page. The student summaries of the information were brief and lacked details. Students were advised to return to the information and add more details to allow for stronger evidence in the final explanation. After this experience, students were given the diagram/model first and collaborated on what changes they saw. Students were then given the analysis organizer and asked to record "what" changes they saw in the diagram/model in column one of the analysis page. The evidence recorded was more detailed. After recording "what" changes occurred using evidence from the diagram/model, students were given the written description of environmental changes. They were then asked to read and collaborate on "why" the changes in horse structures occurred in the second column, matching the changes in the adaptations of the horse with the changes in the environment. This was more successful than giving students the information combined on one page.

- Collaborative students were more successful when using the sort cards. It was especially helpful for them to have the passages from the text on cards to match with the structural changes in the fossil record.
- If working with interdisciplinary teams, the reading and/or language arts members of the team can participate in the completion of the task and use it when working with using textual evidence to support a written explanation or claim.
- In one pilot class, students had a 50/50 split in the preference for how the material was presented. In addition, students enjoyed the choice of how the information was presented to them.
- In one of the pilot administrations, special education teachers all preferred the task cards, however, the students remained split in how they preferred the information presented.

**Extensions and/or other uses after the task is implemented**

- Consider engaging students in other learning experiences that demonstrate the difference between natural selection and selective breeding and genetic technologies. Explore how natural selection affect the gene frequencies in populations and evolution (changes of the frequencies in a gene pool).

- Consider experiences to clarify the time frame for evolution to occur depending on the organism and its environment. The speed at which populations change gene frequencies depends on the reproductive rate and time between generations. Examples of evolution that occurs quickly, such as many bacteria, can be introduced and compared with the time for changes of the horse in the task. These links include videos that highlight this, as well as the effects of human activity on natural selection:
  http://www.hhmi.org/biointeractive/evolution-warp-speed - Evolution at Warp Speed (*E. coli* bacteria can evolve and develop a resistance to bacteria in eleven days.)
  http://www.hhmi.org/biointeractive/selection-tuskless-elephants - Selection for Tuskless Elephants (The effects of poaching on the increase of elephants without tusks in populations)

- Videos to start discussion of selective breeding and variation with possible incorporation of math computation:
  https://youtu.be/PZ0jnHuqsX4 - Secretariat vs. Man O' War
  https://youtu.be/eT50hQINVrI - Secretariat 1973 vs. American Pharaoh 2015

- Video to introduce students to the Hardy-Weinberg equation and how it is used to determine gene frequency to support MS-LS4-6. Students will be exposed to Hardy-Weinberg,S although it is not included in the assessment boundary:
  https://youtu.be/R6La6_kIr9g - Bozeman Science Natural Selection

**Image Attributes:**

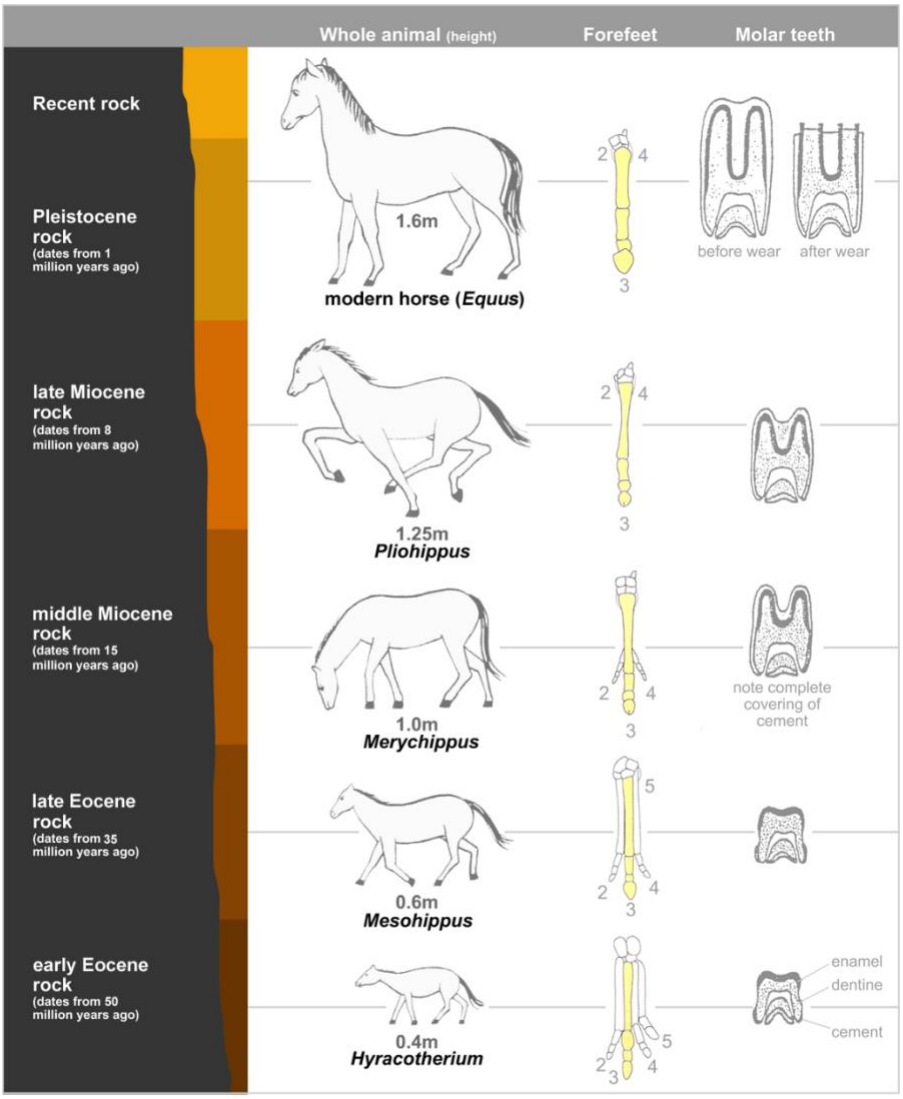
American Saddlebred: “American Saddlebred” by Heather Abounder is licensed under the Creative Commons Attribution 2.0 Generic license

Thoroughbred: In the Public Domain

Through Course Task – Horsing Around

Name:_____ Class Period:_____

# How Did We Get the Modern Horse?




**<u>Change in Environment</u>**

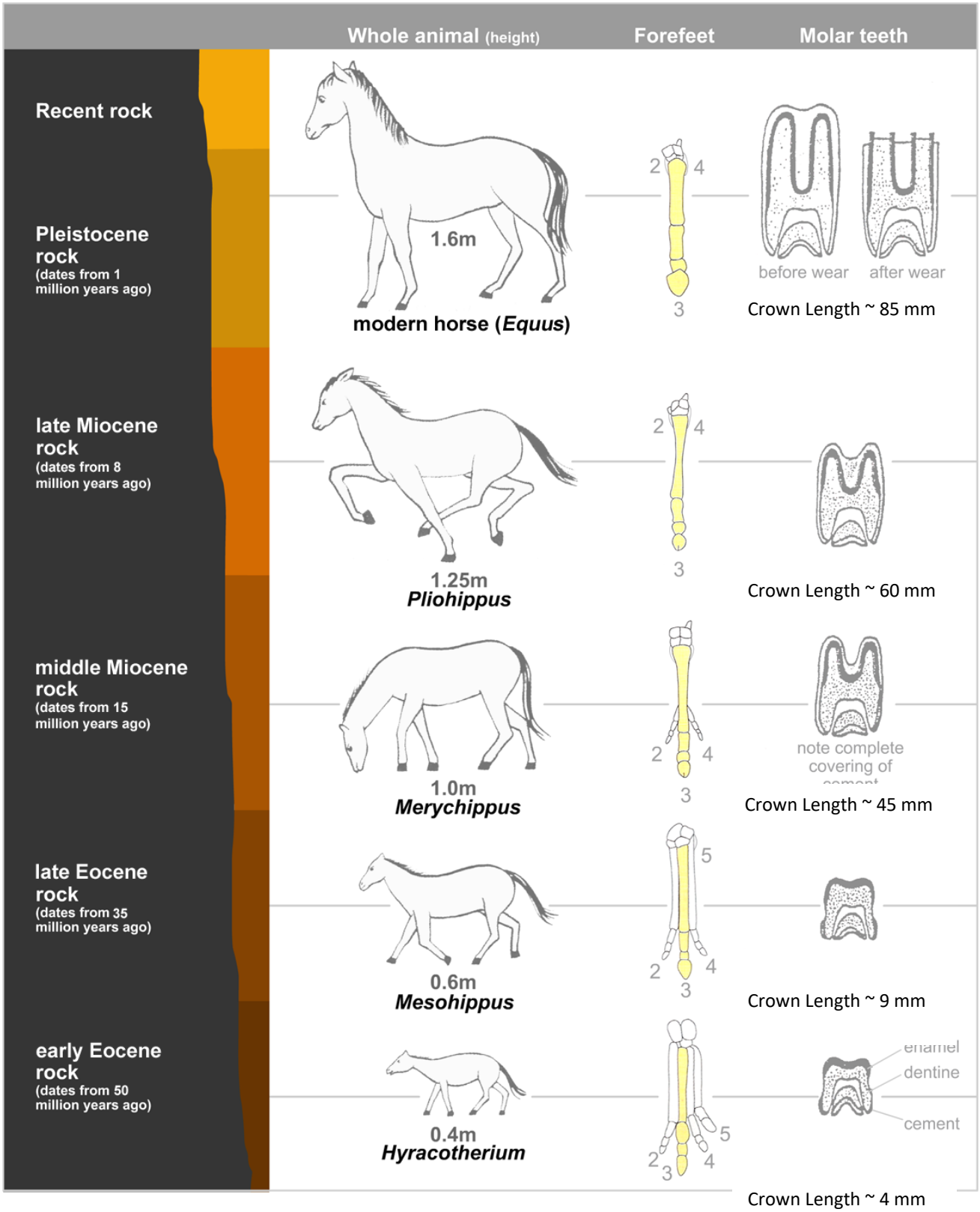
Scientists have been able to piece together a more complete picture of the of the modern day horse's lineage than the lineage for any other organism. Scientists trace the natural selection of the horse involving the gradual development from the fox-sized forest dwelling Hyrocotherium into the large muscular horse we ride and see on the track today.

70 million years ago the environment that was home to the Hyrocotherium was heavily wooded, offering protection from predators, soft moist grounds for walking and plenty of food to eat.

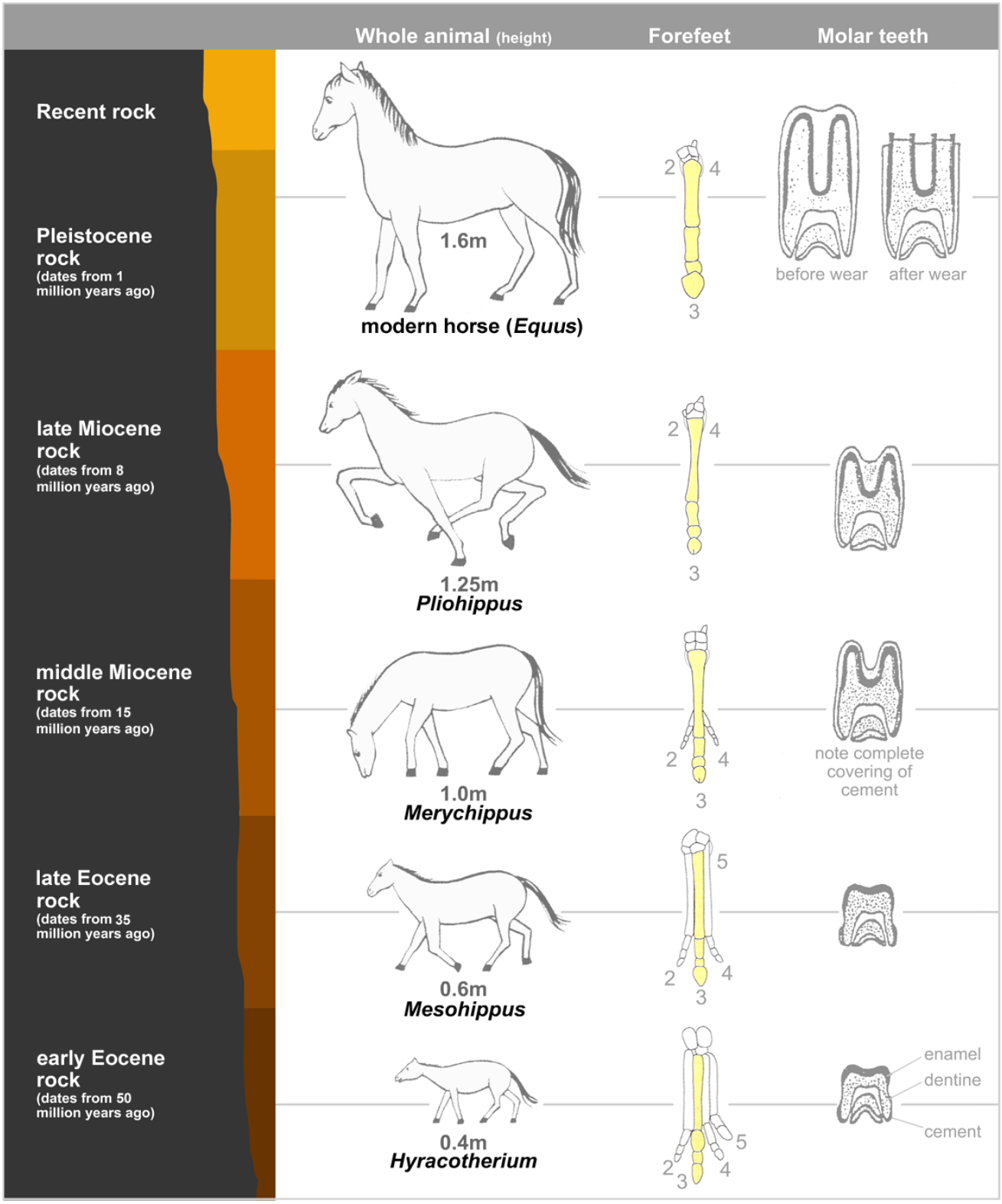
This environment was perfect support for the Hyrocotherium and its short legs with toes, small teeth and body structure.

Over millions of years, the lush forests began to thin and disappear. Grassland eventually replaced the lush tropical forest. Hard, dry soil replaced the once soft moist ground of the environment. The food sources that were once plentiful shifted from soft lush foliage to harder grasses, as grasslands began to replace the forest. As the lush tropical forest disappeared so did cover and protection the horse's predecessor had from the predators, leaving a need to escape from predators.

# Changes that have led to the modern horse



# Changes that have led to the modern horse



# Changes in the Horse's Environment

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Image Courtesy of Bureau of Land Management

Image Courtesy of the National Park Service

# HOW DID WE GET THE MODERN HORSE?

Construct an explanation that includes a claim about the cause and effect relationship between changes in the environment and the progression of changes that has led to the modern day horse.

- Make a claim about the relationship between changes in the horse and changes in the environment.
- Use the graphic and text to support your claim with evidence.
- Finally, provide scientific reasoning detailing how the process of natural selection results in changes that led to the modern horse.

**EXTENSION**

# How did we get the modern horse?

Humans select and breed animals and plants in order to have organisms with traits that fit human needs and desires. Look at the pictures below and answer the questions that follow.

Przewalski's Horse or Asian wild horse

American Saddlebred

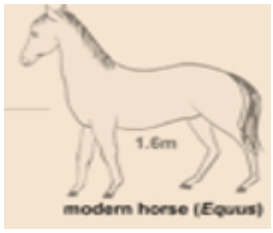
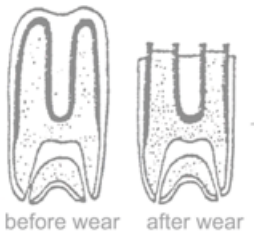
Thoroughbred

A. What are differences in the traits of the horses in the pictures?
B. What would be some challenges for the horses in the two pictures on the right to survive in the environment of the horse in the left picture?
C. How have humans played a role in the appearance of the horses on the right and how is this different from the process of natural selection?

Name:_____ Class Period:_____

# HOW DID we get the modern horse? Analysis Page

After analyzing the graphics and text provided, identify what patterns of change occurred and why the changes occurred. How did the process of natural selection produce the changes recorded?

| | What changes occurred? (Diagram) | Why the changes occurred? (Text) | How the changes occurred? (Natural Selection) |
|---|---|---|---|
| **Height/Muscles**   | | | |
| **Feet/Hooves**  | | | |
| **Teeth**   | | | |

| | | | |
|---|---|---|---|
| **Claim**<br>How did we get the modern horse? | | | |
| **EVIDENCE**<br>Record evidence from graphic analysis and reading organizer.<br><br>What changes occurred and Why the changes occurred? | Height/muscles | Feet/hooves | Teeth |
| **REASONING**<br>Apply scientific principles to explain how changes in the horse occurred.<br><br>How the changes occurred?<br><br>Suggested vocabulary:<br>● Natural Selection<br>● Variation<br>● Inheritance<br>● <br>● <br>● <br>● <br>● | | | |

Name:_____ Class Period:_____

# How did we get the modern horse? Pre-write

# Optional sorting cards (Facilitator pages)

middle Miocene rock
(dates from 15 million years ago)

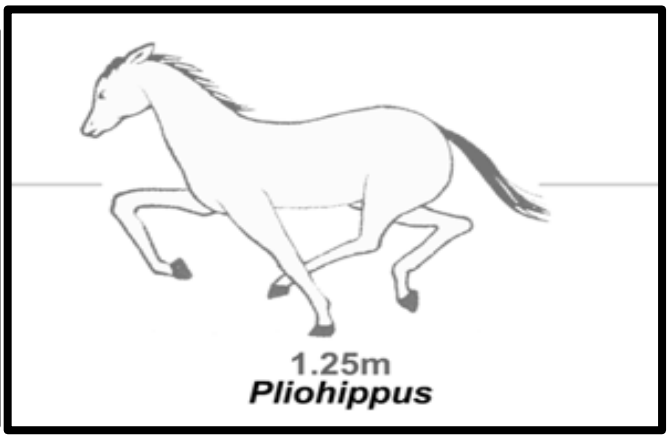
Recent rock

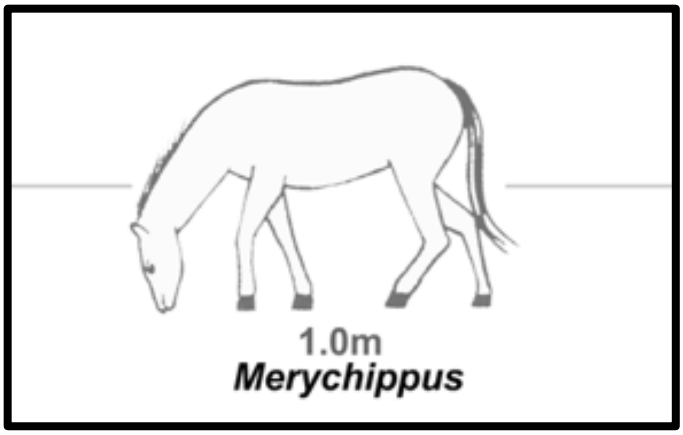
Pleistocene rock
(dates from 1 million years ago)

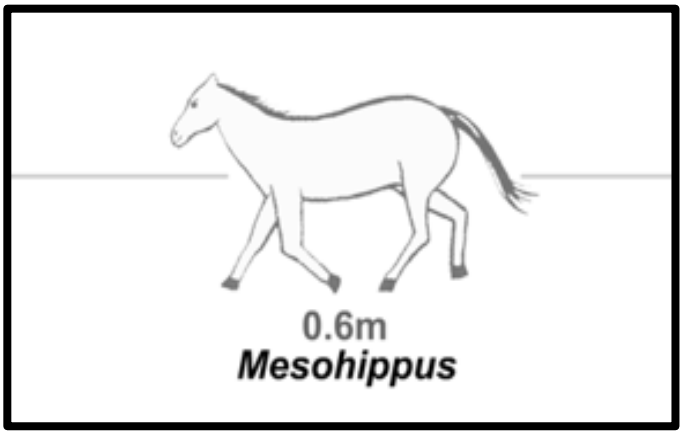
late Eocene rock
(dates from 35 million years ago)

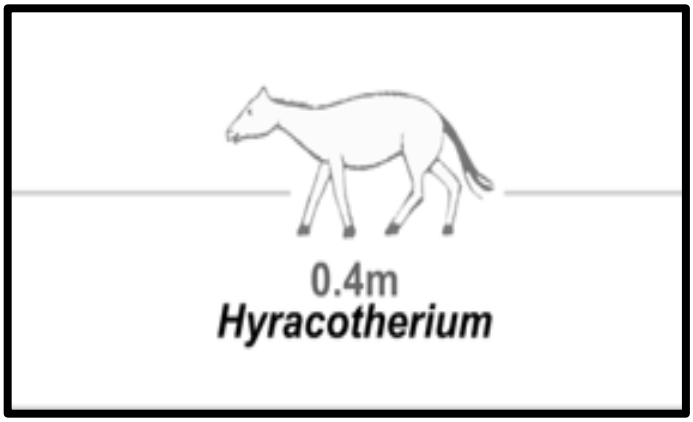
early Eocene rock
(dates from 50 million years ago)

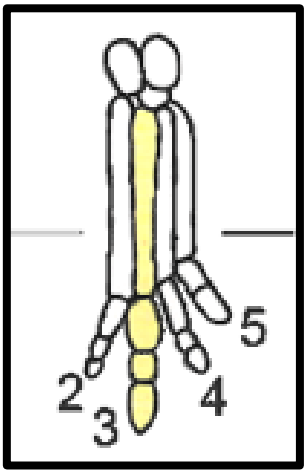
late Miocene rock
(dates from 8 million years ago)




1.0m
Merychippus


0.6m
Mesohippus


0.4m
Hyracotherium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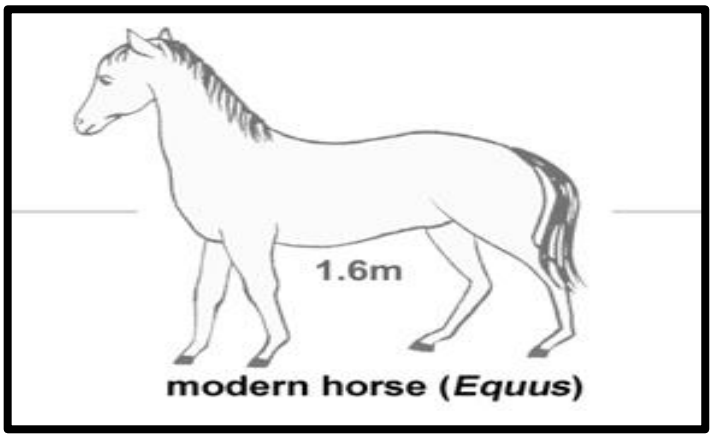
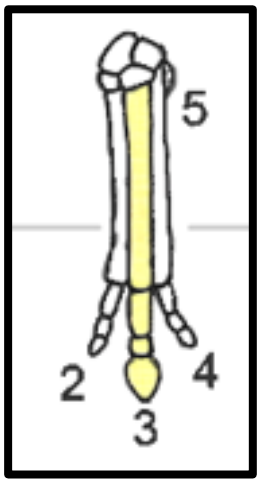

1.6m
modern horse (Equus)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2
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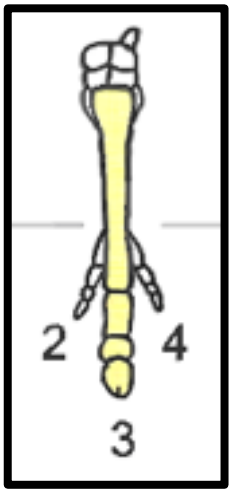
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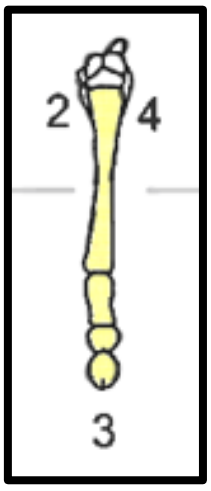
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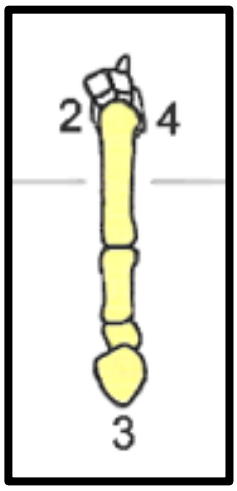
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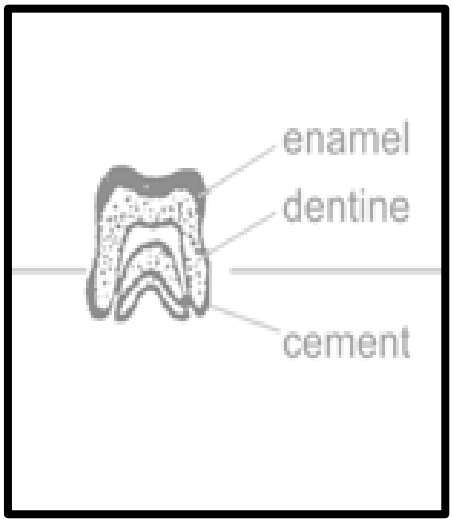
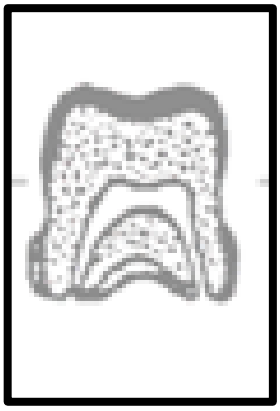
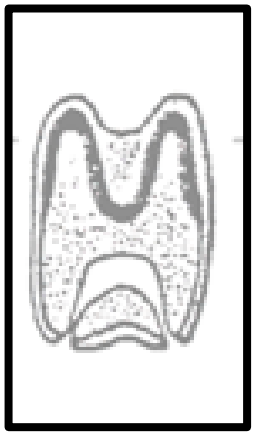
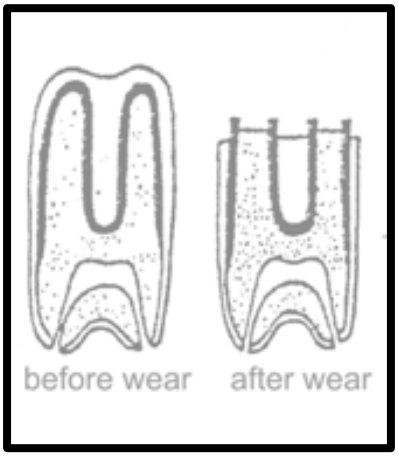
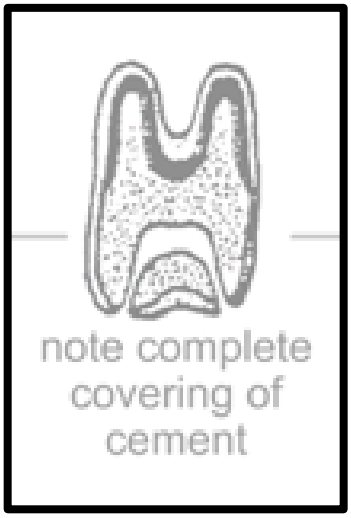

enamel
dentine
cement






before wear
after wear


note complete
covering of
cement