**Student Pages: Exploring Changes in Horse Teeth –Lab Procedure and Data Sheet**

**Introduction:**

Horses are beloved creatures, and paleontologists have compiled one of the most extensive fossil records of any animal that has existed in North America. In this lab you will examine 3D printed models of fossil horse teeth from the Florida Museum of Natural History vertebrate paleontology collection housed at the University of Florida to determine what patterns of change have occurred in horses.

Observe five paintings from different epochs (periods in time) as they are projected. For each image, write down three observations in the space below. Since plants are the basis of an ecosystem, at least one of your observations must deal with the vegetation.

Painting 1 **-** Eocene Epoch (55.8-33.9 Ma)

Painting 2 - Oligocene Epoch (33.9- 23 Ma)

Painting 3 – Miocene Epoch (23-5.3 Ma)

Painting 4 – Pliocene Epoch (5.3 -2.6 Ma)

Painting 5 – Pleistocene Epoch (2.6 – 0.017 Ma)

**Procedure:**

**Part I:**

1. Use the horse data table to familiarize yourself with the 3D models and determine which model tooth corresponds to each listed fossil.

**Part II:**

1. Using the calipers measure the height of each tooth. Measure from the bottom of the crown (NOTE: This does NOT include the root of the tooth) to the highest point on top surface (See diagram A). Next, measure the anterior-posterior length (APL) of each tooth. This is the length from the part of the tooth closest to the horse’s muzzle to the part of the tooth closest to the back of the horse’s jaw. (See diagram B and a modern horse head with teeth embedded in the jaw for clarification, if necessary). Record the measurements on the data sheet provided, below.

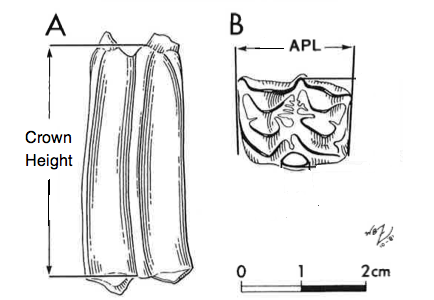


Figure from MacFadden (1988) *Fossil horses from “Eohippus” (Hyracotherium) to Equus, 2: rates of dental evolution revisited*

1. Calculate the hyposodonty index (HI) of each tooth using the following formula:

**HI = crown height/APL**. Record the HI values on the data table.

Student name(s): Date:

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| **Epoch** | **Age  (Ma)** | **Location** | **Species** | **Model Number** | **Crown  Height  (mm)** | **APL (mm)** |  |
| Eocene | 55 | Wyoming | *Sifrhippus sandrae* | **1** |  |  |  |
| Oligocene | 33 | Nebraska | *Mesohippus*  *bairdi.* | **2** | 9.2 mm | 13.8mm | 0.67 |
| Miocene | 18 | Thomas Farms, Gilchrist County, Florida | *Anchitherium clarencei* | **3** | 12.6mm | 19.9mm | 0.63 |
| *Parahippus leonensis* | **4** | 15.9mm | 16.7mm | 0.95 |
| *Archaeohippus blackbergi* | **5** |  |  |  |
|  |  |  | *Parahippus*  *barbouri* | **6** |  |  |  |
| Miocene | 9 | Love Site, Alachua County, Florida | *Calippus*  *elachistus* | **7** |  |  |  |
| *Calippus*  *cerasinus* | **8** | 36.2mm | 17.2mm | 2.11 |
| *Neohipparion*  *trampasense* | **9** |  |  |  |
| Pliocene | 5 | Bone Valley, Polk County, Florida | *Dinohippus mexicanus* | **10** |  |  |  |
| *Neohipparion*  *eurystyle* | **11** |  |  |  |
| *Nannipus aztecus* | **12** |  |  |  |
| Pleistocene | 2 | Santa Fe River Bed, Columbia County, FL | *Nannipus peninsulatus* | **13** |  |  |  |
| Haile Site 15A,  Alachua County, FL | *Equus (Plesippus)*  *simplicidens* | **14** |  |  |  |
| Pleistocene | 0.1 | Waccasassa River Site 9, Levy County, FL | *Equus*  *ferus* | **15** | 79.9mm | 28.0mm | 2.85 |

**Part III:**

1. Graph the tooth measurements using the grid below. Time is the independent variable (x-axis) and the tooth hypsodonty-index (HI) is the dependent variable (y-axis).
2. Add the names of the 5 Epochs below the corresponding year ranges: Eocene, Oligocene, Miocene, Pliocene and Pleistocene to the graph of Time vs. HI

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| **3.4** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **3.2** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **2.8** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **2.4** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **2.0** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **1.6** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **1.2** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **0.8** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **0.4** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **0** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **0** | | **4** | | **8** | | **12** | | **16** | | **20** | | **24** | | **28** | | **32** | | **36** | | **40** | | **44** | | **48** | | **52** | | **56** | |

**Part IV: Changes in Horse Teeth in Relationship to Changes in Plants**

*Complete the following using the provided Plant Epoch Cards:*

1. Read the Plant Epoch Cards. Determine the primary type of plant life present in each epoch as one of the following:

* Mainly forests
* Forests and grasslands, but not savannas
* Primarily grasslands and savannas

1. Using the criteria listed below shade/color directly onto your graph the primary type of plant life present in each epoch. (Note: color the entire space on the graph above the epoch name, not just the epoch name).

* Mainly forests: Green
* Forests and grasslands (not savannas): Orange
* Primarily grasslands and savannas: Yellow

1. Observe the sample plants provided. What are the primary differences between forest leaves and grasses? From the fossil study set, which kind of teeth would be more effective for eating grasses?
2. Using the graph developed in Part III above and the plant information cards, propose the relationship between plant evolution and horse evolution.
3. In this exercise you saw that the Earth’s climate changes over time. If Earth’s climate was to change again and tropical forests covered the majority of the land, how would you expect the morphology of horse teeth to change? (Assume horses have enough genetic diversity present for tooth modifications…. that’s a big assumption to make!)
4. What might happen to modern horses if the climate changed and tropical forests covered the majority of the earth and there was no diversity present in the genes for tooth modification?