GreatHearts®

Life Science 7: The Human Body—Nervous System and the Wonders of Humanity

May 11 – May 15

Time Allotment: 30 minutes per day

Student Name: _____

Teacher Name: _____

Packet Overview

Date	Objective(s)	Page Number
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Additional Notes: Welcome to the last week of new material in Life Science distance learning. Think of the journey you have undertaken…from the attributes of life to plants to insects to vertebrates and finally to the essence of humanity. I am proud of your growth and the responsibility you have undertaken in this challenging of distance learning. Take a moment this week to thank your parents or guardians for their help in your learning during your time away from school. Be well, my fine Great-Hearted scholars!

Life Science Zoom Guided Instruction Hours:

2nd Period: Monday & Wednesday, 11:00 am to 11:50 am

3rd Period: Monday & Wednesday, 1:00 pm to 1:50 pm

4th Period: Tuesday & Thursday, 10:00 am to 10:50 am

5th Period: Tuesday & Thursday, 11:00 am to 11:50 am

6th Period: Tuesday & Thursday, 1:00 pm to 1:50 pm

Academic Honesty

I certify that I completed this assignment independently in accordance with the GHNO Academy Honor Code.

Student signature:

_____

I certify that my student completed this assignment independently in accordance with the GHNO Academy Honor Code.

Parent signature:

_____

Monday, May 11

- Life Science Unit: Human Body—Nervous System and the Wonders of Humanity
- Lesson 1: Nervous System and Senses
- Lesson timeline: **20 minutes** to read pages 500 - 507; **10 minutes** to fill out notes and answer discussion questions.

Objective(s): Be able to do this by the end of this lesson.
1. Explain the overall function of human senses.
2. Assess the intricacies of human sight.

Lesson 1 Socratic Guiding Question: Keep this question in mind as you study
Now that you know the science behind sight, think about our interpretation of what is beautiful. How can we be moved to awe or to emotion through the science of seeing something in nature?

I. Read pages 500 - 507 in your textbook (20 minutes).

II. Notes and discussion questions about textbook reading (15 minutes**)**

1. What are the 6 sense-related things that your textbook mentions? (page 500)
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____

2. Why do you think the textbook included balance? (page 500)

_____
_____

3. What three parts of the eye are involved with the entrance of light into the eye? (page 501)
   a. _____: the clear tissue that covers the front of the eye
   b. _____: the opening through which light enters the eye
   c. _____: a circular structure that surrounds the pupil and regulates the amount of light entering the eye

4. How does light turn into the detailed images when it hits the retina? (page 502)

_____
_____

5. How are vibrations turned into the sounds that we interpret? It sounds almost like how the elephant hears vibrations from the ground! (page 504)

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6. How do the semicircular canals responsible for our sense of balance? (page 505/506)

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Tuesday, May 12

- Life Science Unit: Human Body—Nervous System and the Wonders of Humanity
- Lesson 2: *A Zoologist Looks at Humankind* by Adolf Portman
- Lesson timeline: **30 minutes** to read and annotate the first section of "A Zoologist Looks at Humankind"

Objective(s): Be able to do this by the end of this lesson.
1. Assess the uniqueness of the human development from birth
2. Compare human development with the development of other mammals

Lesson 2 Socratic Guiding Question: Keep this question in mind as you study
Why does Portman spend so much time comparing human babies with primate babies?

I. Read and annotate the following excerpt from *A Zoologist Looks at Humankind* by Adolf Portman (30 minutes). If you finish reading before 30 minutes have elapsed, start reading and annotating the reading for Thursday, May 14.

Excerpts from *A Zoologist Looks at Humankind* by Adolf Portman

THE HELPLESS newborn human reminds us of similar developmental states in mammals and birds; an inner bond of understanding makes the animal mother seem more human to us, more closely related than the animal would otherwise appear to be. This impression of accord goes so deep that it is scarcely noticed how unusual the nature of the human baby actually is, how much it deviates from what is the rule for higher mammals. The characteristics all mammals have in common—loving care of the young and nursing—have diverted our attention from the differences in the ways the various groups develop. To address this matter, we must first look clearly at the special features of human newborns.

The development of mammals whose body structures show little specialization and whose brains are only slightly developed is usually characterized by short periods of gestation, a large number of young in each litter, and the helpless condition of the babies at the moment of birth. In these early stages they are usually hairless, their sensory organs still closed, and the temperature of their bodies still completely dependent on warmth from an external source (insectivores, many rodents, and small carnivores—the marten, in particular). **[**Note: Portman calls this under-developed type of baby animal a term called "altricial"]**

A completely different type of development is shown by more highly organized mammals, whose body structures are more specialized and whose brains are more complex (ungulates [hoofed animals], seals, whales, prosimians, and apes). For these creatures, development within the uterus lasts quite a while, the number of young in each litter is reduced to two or one, and the newborn are well developed, appearing much like adult animals in both form and behavior. **[**Note: Portman call this type of well-developed type of a baby animal a term called "precocial"]**

Cats and dogs fall somewhere between these two extreme, a position that also corresponds to their degree of specialization and level of organization: the young are indeed

altricial but at the moment of birth are already much more developed than baby rats or hedgehogs. It is no accident that with dogs and cats the number of young also falls between the two previously mentioned extremes…

Thus far, we have only been able to verify that such correlations exist. We are striving to clarify these relationships, which in many instances are so inadequately understood, because they contain information about the human situation. Our attention is first drawn to the second group (**precocial)** of correlations, that of the higher mammals, which include the related group of the highest mammals, the so-called primates, and, with them, the human.

We have long known that all primates have a small number of young. From the lowest level of prosimian organization to the great apes, we find "human" situations: one baby, rarely two; only in the marmosets of South American is the birth of twins common.

Newborn primates are precocial. They are all born with open eyes and well-developed sensory organs and, beginning at the earliest stage of life, are capable of all kinds of movements. The babies of a few species of prosimians do not open their eyes until just after birth, but, in general, the early independence of small prosimians—lemurs—is striking. But the offspring of guenons, macaques, and baboons are also so independent that no one who has observed these creatures at the time of their birth would hesitate to label them precocial. As soon as they are born, they experience a special compulsion to cling, gripping their mothers' furry hides with their strong hands and feet. Even though the mother sometimes lays a protective arm around her baby or holds on to it now and then with her hand, the baby supports itself, and does not even lose its grip when the adult goes swinging through the branches in bold leaps. In calmer moments the infant clambers around a bit on the mother; she is the first "tree" of its young ape's life, and for a long while yet, she will pull the youngster sharply back by the tail when it tries to get too far from her. The clinging instinct of young apes is an appropriate defense mechanism against the dangers of life in the trees; this instinct completely dominates the baby's early behavior, concealing the great capacity for independent movement that is actually present in the newborn primate.

When we realize what a strong compulsion this drive exerts, requiring as it does that the hands and feet be so completely in the service of holding on, the freedom that a newborn human has with its hands and feet seems quite a contrast—all the more so since our baby is so much more helpless than the baby ape. The free play of the limbs, which gives our infant possibilities so much richer than those available to the newborn ape, reminds us that our birth condition is not merely "helpless" but also entails important freedoms.

Comparison of our birth state with that of other mammals must be based on the infant forms of New World primates and of guenons, baboons, and related species. At first glance, this might seem strange, for it appears clear that the initial stages of juvenile development in anthropoid apes are more closely related to our own. Briefly, then, the choice of our starting point must be justified.

Prosimians have taken the step beyond the old altricial level. Just after five months, the lemur begins life on its own; we know that the mouse lemur is capable of reproduction when it is

seven to eight months old. At the ape level of primate evolution the period of time during which the infant is closely tied to the other lengthens to more than one and one-half years in South American howler monkeys, and to one year in macaques and Old World baboons. A longer period of sexual immaturity creates an extended juvenile period, which determines life within the group often on into the fourth year, even into the fifth year for many male macaques. Still more years may pass before the offspring achieves full status within the group.

EVERY COMPARATIVE classification of newborn humans must proceed from the striking fact that the group of mammals from which both humans and the great apes have emerged exhibits a secondary birth state for mammals. The form of the newborn is like that of the adult in bodily proportions, particularly in the limbs, and the infant is born with the eyes open.

There is a little noticed but significant sign that, at birth, the developmental stage of primates must be termed precocial: the fetal development of the sensory organs! To be more precise, within the womb, all primates go through a stage during which the outer sensory openings are closed.

Why the eyelids, the ear passages, and the nasal openings close during the fetal stage [of precocial animals] in the womb and open again just before birth cannot be explained functionally, for during this period of time there is no change in the living conditions in the womb that would affect these epidermal structures. In contrast, such closures make sense for altricial infants and can be regarded as preparation for an early birth; the closures provide the still undeveloped sensory organ with the necessary liquid environment and protect it from exposure to air. Thus, closure provides for the peripheral part of the sensory organ what a special sac, the amnion, provided at earlier developmental stages for the whole germ: the protection offered by the primary, aqueous environment.

Primates still in the womb go through a stage that, with regard to form, is comparable to the birth state of an altricial infant. Therefore, by the time a primate is born, its growth has arrived at a more advanced developmental stage.

Humans, too, while still in the womb, undergo all these changes in the sensory organs, changes that are characteristic of altricial infants. The most noticed change is the sealing of the eyelids, which grow together during the third fetal month and open again at the end of the fifth month. If humans were born as simple altricial infants, something like the helpless young of a squirrel or a marten, they would have to be born at about this five-month developmental stage. In reality, however, humans mature further in the womb to the precocial stage of colts or calves, with open sensory organs and well-developed locomotor systems; they attain a level of formation that is characteristic of all higher mammals. Our insight will continue to be sharply restricted if we persist in the opinion that we are only dealing with a meagerly developed altricial infant...

The morphologically demonstrated affiliation of newborn humans, and of all infant primates, with the level of the precocial type is further emphasized by the fact that the composition of human milk is much more like that of mammals with precocial infants than, say, dog or rat milk is.

We assert once again that, in the following, the newborn human will be considered from the morphological standpoint as a creature affiliated with the precocial mammals. This can be only one of many perspectives of the problem under consideration, but it will help us to see the most striking trait of our birth state— helplessness—in its true context: not as the primitive, somatic immaturity of an altricial infant, but as a very exceptional situation within the mammalian group. In fact, with respect to the full precocial type, humans are secondarily altricial.

Just the study of bodily proportions clearly brings out the uniqueness of our babies. From birth on, the young of higher mammals maintain bodily proportions close to those of the adult forms. Thus, on the first day of their lives, foals, fawns, young whales, and small harbor seals are already miniature versions of their parents, with the only particularly conspicuous difference being the relative size of the head (and the brain); in the same way, the newborn ape is similar to the adult in the size ratio of limb and torso. Anthropoids also follow this rule. The long limbs of orangutan or gorilla fetuses are immediately conspicuous.

How differently the newborn human is built! How different are our limbs from their ultimate state! Comparisons based on growth provide a useful, numerical expression of this important difference between anthropoids and humans. We take a length of a part of the body at birth as the unit with which to compare the same part of the mature body. If the ultimate state is a proportional enlargement of the form at birth, then the growth values of the part remain relatively close. This is true for the torso, arms, and legs of chimpanzees, whereas in humans, the corresponding values are much further apart.

Human torsos, arms, and legs must each cover a completely different developmental trajectory to reach the size of the adult state; the proportions in the human newborn are completely different from those of the mature form. This much we can tell just by looking…

Wednesday, May 6

- Life Science Unit: Human Body—Nervous System and the Wonders of Humanity
- Lesson 3: The Wonders of Humanity
- Lesson timeline: **30 minutes** to complete notes and discussion questions about yesterday's reading of *A Zoologist Looks at Humankind*.

Objective(s): Be able to do this by the end of this lesson.
1. Assess the uniqueness of the human development from birth
2. Compare human development with the development of other mammals

Lesson 3 Socratic Guiding Question: Keep this question in mind as you study!
Why does Portman spend so much time comparing human babies with primate babies?

I. Review annotations from yesterday's reading. If you didn't finish reading yesterday's section by Portman please do so. (5 minutes**)**

II. Fill in notes and answer discussion questions. (25 minutes**) If you finish answering the questions, before 30 minutes have elapsed, start reading and annotating Thursday's reading.**

1. What are the characteristics of mammals "whose bodies show little specialization and where brains are only slightly developed"? (**altricial** baby mammals)

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_____

2. Describe newborn primates using bullet points. (**precocial** baby mammals)

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3. Portman makes a correlation to the number of offspring as a marker of higher levels of development. Why?

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4. Why does Portman call human infants "secondarily altricial"?

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5. Why do you think Portman describes the importance of the bodily proportions of higher mammals as infants?

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Thursday, April 30

- Life Science Unit: Human Body—Nervous System and the Wonders of Humanity
- Lesson 4: Nervous System
- Lesson timeline: **30 minutes** to read and annotate the last section of *A Zoologist Looks at Humankind*.

Objective(s): Be able to do this by the end of this lesson.
1. Judge the uniqueness of humanity based on Portman's description of human development.

Lesson 4 Socratic Guiding Question: Keep this question in mind as you study!
For many years, doctors and scientists have concluded that the timing of the birth of human babies corresponds to the size of the infant head relative to the size of the mother's pelvis. Portman expresses a different opinion about why a baby is born after 9 months of pregnancy. What is his opinion, and do you agree?

I. Read and annotate the excerpt below from *A Zoologist Looks at Humankind* by Adolf Portman. (30 minutes)

Excerpt from *A Zoologist Looks at Humankind*:

The First Year of Life

A HELPLESS altricial infant—that is how the newborn human looks to a zoologist. Are we aware that this fact transgresses the rule for mammals? For a moment, let us try to imagine how a human would have to be at birth if it were really subject to the same laws of development as the forms related to it. Such an attempt is not just idle speculation; it serves to establish a possible design against which the unusual aspects of our actual development can finally be measured.

Physiological Earlier Birth

NEWBORNS OF all highly organized mammalian groups are precocial, and their sensory organs are well developed and capable of functioning. In form, apart from some slight proportional deviations, particularly in the size of the head, these newborns are miniature versions of the mature form, and their behavior and locomotion are to a large extent the same as their parents'. The infant also has command of the means of social communication that are typical for its species. This is the state at birth for ungulates, seals, and whales, as well as for anthropoids. As we have seen, regard to development of overall form these statements are also true for the great apes, about which we will have more to say. In addition, many specialized rodents with a reduced number of young and (in the porcupine group) longer gestation periods, as well as the extremely specialized anteater and the South American sloth, which have only one offspring, follow the same laws.

In accordance with this definition, a true mammal of the human type would have to have a newborn whose bodily proportions are similar to those of the adult, one that can assume the erect posture appropriate to its species, and that has command of at least the rudiments of our communication system—language (and the language of gestures). This theoretically necessary stage does in fact exist during the course of our development: the stage is reached about a year after birth. After one year, the human attains the degree of formation in keeping with its species

that a true mammal must have already realized by the time of its birth. Therefore, if the human were to arrive at this state in the true mammalian mode, our pregnancy would have to be longer than it is by about that one year; it would have to last for about twenty-one months. This figure of twenty-one months does not of course have to be an absolute figure. It depends a great deal on how closely we want our design to resemble the mature form; accordingly, we would have to "ask for" a few months more or less. Of critical importance for our further investigation is the necessity of stipulating a gestation period roughly one year longer for a manlike mammal: for a true animal-man (Tiermensch) or human-animal (Menschentier).

In so doing, we are not indulging in impossible flights of fancy. Such long gestation periods do exist. The Indian elephant gives birth after twenty-one or twenty-two months, and this nimble baby elephant, about one meter high at the shoulder and weighing about 100 kilograms, is a good example of all the demands we have just spelled out. The gestation period of sperm whales is probably about sixteen months; this animal, too, gives birth to a well-developed baby: at birth, the "little one" is four meters long. Our preliminary conclusion is only that the actual length of human pregnancy is much less than it should be for typical mammalian development at our level of organization.

There is a striking contrast between the early growth of the great apes and that of humans. The weight of the apes increases at a relatively even rate, beginning low and, by the end of the observation period, surpassing in all three species the body weight of humans of the same age. By contrast, our own growth curve begins far above the starting point for the apes, rises considerably during the first year, then makes a conspicuous transition to the special, very slow development that remains for us through the years. This sharp division of the growth curve into two parts during our first years is found in no other precocial type, not even in the great apes. It is peculiar to our species.

Assessment of the Duration of Pregnancy

THE POINT on the developmental continuum at which birth occurs can be commented on from very different points of view. Either all the facts of the life-form of a species are taken into consideration, or the evaluation of the timing is based more on the circumstances immediately surrounding the moment of birth. The latter approach dominates most discussions of this problem.

Biologists have drawn other, more complex correlations into the consideration of the issue. Thus, we often see the moment of birth as being connected to the high level of human brain formation, as being "determined" by the dimensional relationship between the width of the birth canal and the circumference of the baby's head. There is no doubt that such a relationship based on size exists. But it is impossible for the biologist to orient this relationship with regard to cause and effect: to say, for example, that the adult form is the given and that therefore, the size of the mother's pelvis determines the possible mass of the infant's head. Arguments of this kind are probably used more or less consciously all too frequently in biology, but no matter how often they are used, they do not become more acceptable. In such an instance, it is much too simple to explain two sizes that occur in relationship to each other by saying that one is a given and the other is dependent on it.

All higher mammals have long gestation periods, the length of which stands in clear relation to the level of organization of the central nervous system. Following the developmental

plan fixed in the genes of the species, the entire motor apparatus, the species-specific posture, and the typical system of instincts form inside the mother's body, in the uterus—all in harmony with an environment that has also been to a large extent genetically assigned to each species. The basics of movement and behavior take shape within the mother's body, far from later sources of stimulation and yet related to these future stimuli, to the environment yet to come. There is no difference between the appropriate formation of the hooves and legs of a foal or a fawn and the developmental mode of its posture, locomotion, and voice.

Three significant events characterize the first year of human life: the attaining of erect posture, the learning of an actual verbal language, and the entrance into the realm of technical thinking and behaving…

Erect Posture

NO OTHER mammal attains its species-specific posture as humans do, through active striving and not until long after birth. Even though in many animals, the first movements are immature and labored, and in some circumstances concealed by a powerful clinging instinct, as in the great apes, the entire body posture and the motor patterns of such forms are typical of their group and, in general characteristics, are similar to those of their parents. The newborn ape has to learn and practice a richer program of species-typical movements than, for example, the newborn ungulate. But it does not first have to mature in bodily proportions, as a human does, and does not have to learn species-specific erect posture at the end of its first year of life.

We give here only a few steps out of the entire process of attaining erect posture, with the average times when they occur:

SECOND TO THIRD MONTH: mastery of holding the head erect;

FIFTH TO SIXTH MONTH: striving to sit up, and succeeding;

SIXTH TO EIGHTH MONTH: standing up, the whole body erect, with the help of adults and supporting self on objects;

ELEVENTH TO TWELFTH MONTH: standing alone for the first time and undertaking the first independent steps; subsequent rapid learning to stand a walk alone;

ELEVENTH TO THIRTEENTH MONTH: learning to get up from the position of lying flat.

We are not so concerned with walking upright, as is usually the case, but with standing, with erect posture, for this is what is special and human. Walking in this position is the relatively simple function of a very primitive neuromuscular organization common to all quadrupeds—alternate movements of the limbs. This type of movement is strongly built into the genetic makeup of all quadrupeds: Thus, we observe in immature birds first the alternating movements of the little wings, a primitive and useless type of movement, which only later is succeeded by the simultaneous wing beats suitable for flight, and in many songbirds even by a simultaneous hopping motion of the legs.

The true significance of the slow acquisition of completely erect posture and the necessary supporting physical structures is still difficult to understand. We must still be satisfied with pointing out that the formation of one of the most characteristic marks of the human being is postponed until a time when major mental developmental processes, the formation of our world experience, are also taking place.

In the distinctive process of learning and fixating species-specific posture, the circumstance that the legs of infants are very short, making attempts to stand that much easier, is of considerable assistance. As early as the fifth prenatal month, growth of the legs has already fallen behind that of the arms, although the ultimate size relationship would lead us to expect the opposite. If we see in this early retardation of leg growth a process that is coordinated with the special way in which the human acquires erect posture, we also understand the other striking fact: intensive growth of our legs does not set in immediately after birth, after the conceivable restrictive environment of the uterus has been left behind, but only very gradually after the sixth month of the extrauterine spring. Not until the beginning of attempts to stand, therefore, and more particularly, after the acquisition of erect posture, do the legs begin to grow more quickly…

Language

Preceding any acquisition of language is the human capability—genetically predetermined and always at hand later as a possible reaction—of crying, growling, squealing, or clicking, which is to say, of producing general expressions of inner states. We shall not discuss here the difficult problems of laughing and crying, for language learning can be observed independently of the study of these phenomena; nevertheless, it is clear that these problems must be topics in any complete biological discussion of human behavior.

In the third to fourth months, the child begins the manifold attempts to make the movements with which, especially in the fifth and sixth months, it produces sounds. This exercising leads to babbling, to actual monologues of babbling, with which the tiny creature produces a veritable arsenal of sound units, many of which it will no longer use when it learns its native language and will have to master again when it learns a foreign language. This phase, with its wealth of elements, contains the possibility for learning any human language whatsoever.

Insightful Behavior

JUST AS striking as the preparation for standing and the mimicking of the first verbal structures is the behavioral transition from simple unreflective imitation, which appears early, along with instinctual behavior, to actual insightful behavior. That even imitation is coupled with momentary acts of insight and understanding is just as clear during this early period of childhood development as it is in chimpanzees. For this reason, the "aha!" experience is presented by psychologists as one of the most interesting borderline accomplishments of chimpanzees. However, the decisive factor in human children is the ultimate surpassing of this stage at about the tenth month of the first year, the attainment of a level at which insight, the understanding of meaningful contexts, becomes a typical element of our behavior…

Oneness of Developmental Events

Ungulates and apes, seals and whales—all mature in seclusion, in the mother's body. Perhaps this assertion strikes us as doubtful, given what we know of the juvenile period of higher animals, of the period of experimentation and learning within the group, of the impressive early

phase of an ape's life, and of the life of an anthropoid ape in particular. That is why we must consider the singular nature of our own birth state, the high multiplier factor of our brain, and the different proportions of limbs and torso in order to understand the uniqueness of our early situation. For a moment, we must focus intently on the situation we find when we study mammals other than humans to establish the developmental norms of the animal group; we must try to imagine the developing human spending the important maturation period of its first year of life in the dark, moist, uniform warmth of its mother's womb. Only then, by contrasting that vision with the reality of human development that is before us, will we understand the completely special, separate nature of our mode of development. Then, as we reflect on these things, the unusual, intimate relationship that exists between the special nature of human behavior and the remarkable, atypical development of our children will become apparent step by step. It will gradually become clear that world-open behavior of the mature form is directly related to early contact with the richness of the world, an opportunity available only to the human!

Friday, May 8

- Life Science Unit: Human Body—Nervous System and the Wonders of Humanity
- Lesson 5: The Human—Singularly Unique
- Lesson timeline: **30 minutes** to fill out notes and answer discussion questions from yesterday's reading.

Objective(s): Be able to do this by the end of this lesson.
1. Judge the uniqueness of humanity.

Lesson 5 Socratic Guiding Question: Keep this question in mind as you study!
We have discussed this in class on numerous occasions, but it's time to revisit it. Does Portman justify Aristotle's claim that humans are the only rationale living creatures?

I. Fill in notes and answer discussion questions. (30 minutes)

1. What is the connection between the size of the infant head and the pelvis (hips) of the mature human form?

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2. What "three significant events characterize the first year of human life?"

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3. Summarize Portman's conclusion about the importance of the upright human form as a step towards the uniqueness of humanity?

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****One more question is on the next page. This question is a minor assessment and should take you 15 minutes to answer. Remember to cite specific examples from the text to make your case.**

4. (**MINOR ASSESSMENT QUESTION**—**10 points**) We have discussed this in class on numerous occasions, but it's time to revisit it. Does Portman's detailed explanation about the unique development of human infants justify Aristotle's claim that humans are the only rationale living creatures? Why or why not?