

Remote Learning Packet

There is no need to submit this packet at the end of the week. Enjoy your summer break!

Week 9: May 25-29, 2020

Course: Nature of Science

Teacher(s): Mr. Brandolini, Mr. Mooney, and Mr. Schuler

Monday, May 25

Happy Memorial Day! No School!

Tuesday, May 26 - Friday May 29

Welcome, dear students, to your last assignment for Nature of Science this year! We began this year of study with Aristotle's words: "*All men by nature desire to know.*" How true this is! We have spent the year learning how to *know* things, specifically how to know the *natural world*. First we learned about how we encounter the natural world through our five senses and how we can use them to know things, and then thought about what exactly this "nature" was that we were trying to know. From there we moved on to the three main branches of knowledge about nature: Biology, Chemistry, and Physics.

But what has been *the point* of all this studying? That is, what is the *final cause* of Nature of Science class? The final cause of your study has been to enable you to have a deeper and more profound knowledge of the natural world around you, so that every natural thing--whether it be a rock, or a sunflower, or a chicken in your backyard--is better known and better loved by you.

Today, it is time to take everything that you have learned and put it to practice with one natural, living being of your choosing. Since you will be spending time and care with this living creature, be sure to choose a natural being that you really want to know more deeply. This could be a particular flower in your backyard, or one of the squirrels you see roaming around the neighborhood, or even a beloved pet. Please choose something that is *irrational*--that is, do not observe a human being. So, take a moment to think about which natural being you want to study, and let's get started!

(Note: Since you no longer have your textbook, copies of the relevant pages of your textbook have been attached to the back of this packet. You do not need to read these pages, but you may refer to them if you need a refresher on any idea.)

Step 1: Choose your natural living thing.

What natural being have you chosen to study? _____

First Beginnings of Natural Science

Before you get started, recall to mind the principles for the observation of living beings that we learned many moons ago. **Page 50** of your textbook lists all four. (Note: Since you no longer have your textbook, copies of the relevant pages of your textbook have been attached to the back of this packet. You do not need to read these page

1. Do not _____. Our senses are more awake and more receptive when we are quiet.
2. _____ at what is actually in front of you, and ignore (temporarily) what you may know about the thing. Your knowledge can distract you from noticing what is right in front of you.
3. Look with focus and _____. Isolate one part or one quality of the thing at a time, and spend time observing it before your eye drifts to some other part of quality.
4. Make _____ on paper about your observations while you are observing.

Step 2: Sense Knowledge

What can you know about it from each of your senses (try to use as many as is prudent!)

Sense	Description
Sight	
Touch	
Smell	
Hearing	
Taste	

(worksheet continues on the next page)


Step 3: The Ten Categories

Identify the Ten Categories of your natural being.

Category	Description
1. Substance - "What is the thing?"	
2. Quantity - "How much/many is it?"	
3. Quality - "What kind of thing is it?"	
4. Relation - "How is the thing related to other things?"	
5. Action - "What does the thing do to other things?"	
6. Passion - "What is being done to thing thing by something else?"	
7. Time - "When is the thing acting or being acted on?"	
8. Place - "Where is the thing?"	
9. Position - "In what position is the thing?"	
10. Possession - "What does the thing have?"	

Step 4: Sketch

Now that you have observed this creature for a time, go ahead and make a sketch of it. Be as detailed as you can!



Step 5: Nature

Does your creature seem to have any “inborn impulse to change”? List anything that your creature seems to be doing “by nature”?

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In which category does your creature belong on the Porphyrian Tree? _____

Step 6: The Four Causes

What, in brief, are the four causes of your natural being? **Pages 45-46** offer very helpful definitions and summaries of each of the Four Causes.

Material Cause (What is it made out of?)	
Formal Cause (What is it? Give the essential definition.)	
Efficient Cause (Who/What moves it or brings it into existence?)	
Final Cause (Why does it exist? What is its purpose or goal?)	

Biology

Step 7: Heterogeneity and the Relation of Parts to the Total Form

In this section, let's focus on your creature's heterogeneity and the relation of its parts to its total Form. Look at your creature and consider the following questions: Is your creature heterogenous (made up of multiple parts - p. 65)? What are the different parts and how are they different from one another? How does each organ have a form of its own that is suited to its final cause? What is the final cause of each part? What good does it do the creature? For the sake of this exercise, choose three key parts and answer the questions in the spaces below.

Part 1

Name of Part	
What is the part's Final Cause?	
What good does the part do for the whole?	

Part 2

Name of Part	
What is the part's Final Cause?	
What good does the part do for the whole?	

Part 3

Name of Part	
What is the part's Final Cause?	
What good does the part do for the whole?	

In spite of its many material parts (i.e. its heterogeneity), recall that it is actually *one whole* thing. It is not a heap of material that can be reduced to atoms or carbon, but one *natural whole*. Now consider: would your creature be the same thing if it were dead? Why not? What would be missing?

Step 9: Embryology

Imagine how your creature must have grown and changed: has it always been the same thing? At what moment did it start being the kind of thing that it is. Think back to our study of embryology to help you with this question.

- a. When it was born/when the seed sprouted
- b. When the egg/seed was fertilized (when it was a zygote)
- c. When it was a mature creature
- d. When there were at least 100 cells
- e. When it was a gastrula

Step 10: The Soul

What kind of soul does your creature have? What powers of soul does it clearly have? Do you see specific evidence that it has these powers? **Page 76** lists the kinds of souls (Rational, Perceptive, and Nutritive) and their powers and offers an explanation.

Kind of Soul	Powers	Your evidence that this is the correct soul type

Chemistry

Step 11: Different Aspects of the Material Cause

Now let's think now about the Material Cause. With living things, the material cause is less important than the formal cause, but it is still one of four causes and is very important! Choose **three** of the following quantities to describe about your creature. You may not be able to be very precise, so you can say things like "about as much volume as a box of tissues," or comparisons like that.

Identify **three** of the following: volume, weight, temperature, mass, density, and inertia.

Quantity	Description
<u>Volume</u> : How much space does it take up?	
<u>Weight</u> : How heavy is it?	
<u>Temperature</u> : How hot/cold is it?	
<u>Mass</u> - How much matter does it have?	
<u>Density</u> - How tightly/loosely packed together is the matter?	
<u>Inertia</u> - How much does it resist changes in motion?	

Step 12: Origin of Material Cause

Where do you think the material of your animal came from? How does it relate to the food it ate? What will happen to the material of your creature when it dies?

Step 13: The Ultimate Particles of Matter

Take a moment to think about your creature in terms of the four elements. Fill out the chart below, gauging how much of each of the four elements your creature seems to be made of (circle or shade each box that applies):

Fire	Almost none in the creature	Very little of this element	Some, but not much	A good amount of this element	Almost entirely made of this element
Earth	Almost none in the creature	Very little of this element	Some, but not much	A good amount of this element	Almost entirely made of this element
Water	Almost none in the creature	Very little of this element	Some, but not much	A good amount of this element	Almost entirely made of this element
Air	Almost none in the creature	Very little of this element	Some, but not much	A good amount of this element	Almost entirely made of this element

How would a modern chemist describe what is happening with your creature at the level of ultimate (atomic and subatomic) particles? Is this description something that you know through your sense alone?

Physics

Step 14: Motion and Change

Identify an example of each kind of motion in your creature. For some, you may have to imagine something it did in the past or will do in the future (if you cannot observe it happening at the moment).

Kind of Motion	Example of this Kind of Motion in Your Creature
<u>Locomotion</u> : a change from place to place	
<u>Increase and Decrease</u> : a change in quantity (size)	
<u>Alteration</u> : a change of quality (e.g. changing color, texture, etc.)	
<u>Substantial Change</u> : a change of substance (note: for a living creature, this only happens at the first moment of life, and at death.)	

Step 15: A Closer Look at Locomotion

Describe your creature's locomotion in detail.

Identify the four causes of its locomotion.

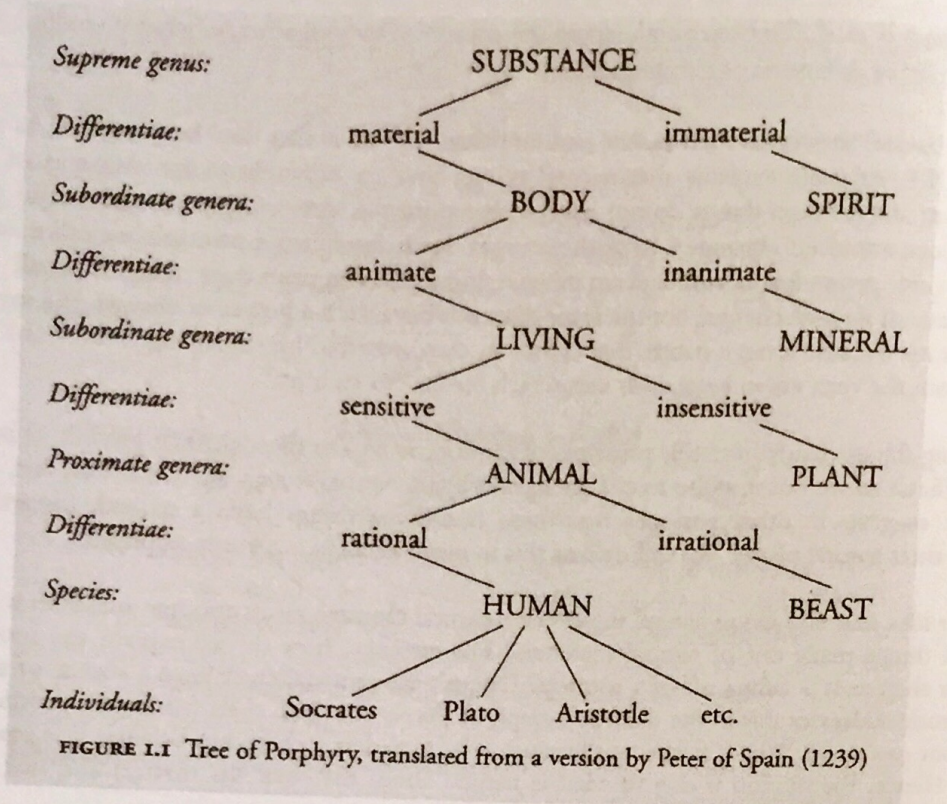
Material	
Formal	
Efficient	
Final	

Conclusion

Congratulations on completing Nature of Science! In one sense, this is the finish line; in another sense, it is only the beginning. The sixth-grade "Nature of Science" class lasts only one year, but the study of the natural world is a pursuit for a whole lifetime! Let us continue, then, with reverence and wonder (and a "sharpshooter" eye!) to observe the natural world around us and to grow in knowledge and love of it.

THE PORPHYRIAN TREE

The “Porphyrian Tree” is taken from Porphyry’s *Isagoge*, a book that has been used for almost 2,000 years to help students understand Aristotle’s categories. This tree helps us see, first of all, an ordered arrangement of the different kinds of beings that exist. It is also helpful for understanding that not all substances that exist are material. Comprehending and mastering this tree will be essential for your understanding of the kinds of natural beings that exist.



All of the terms in capital letters are genera or species, and all of the lowercase terms are differentiae, except for the individual humans at the bottom. To understand the tree, you must know what the terms “genus”, “species”, and “difference” mean. Genus and species are relative terms, which means that each one is understood in relation to the other.

Genus (from Gk. γένος, meaning “family, clan; ancestor”) – a class with more than one species within it, which share something in common with one another.

Humans and beasts are in the genus of animals.

ARISTOTLE'S FOUR CAUSES

In the passage from Book II.3 of the *Physics*, Aristotle is reflecting on what knowledge is, or on what it means for us to say we *know* a thing. As he suggests, having a grasp of the *why* of something is the essential mark of knowledge. He then goes on to list four "causes", which will be explained more below. What does knowledge have to do with causes? It is important to understand that the "causes" Aristotle describes are the causes of beings, i.e., the reasons why certain beings are the way they are. When we ask, for example, "Why does the pen fall to the floor?", the answer begins with "because...". 'Why' questions are therefore questions that search for causes. When we grasp the causes of a thing, this is what we call *knowing* it in the richest sense.

There are four causes that we should look for when trying to understand something. Here they are summarized in the same order that Aristotle describes them:

1. **The Material Cause** – that out of which a thing is made
2. **The Formal Cause** – the essence or nature of a thing, what a thing is
3. **The Efficient Cause** (moving cause) – (a) the source of a thing's movement or (b) the cause of its existence
4. **The Final Cause** – that for the sake of which a thing exists, its purpose, end, aim, or goal

The causes can also be understood as answers to the following questions about an object:

1. Material Cause – What is it made out of?
2. Formal Cause – What is it? What kind of thing is it?
3. Efficient Cause – Who/what moves it or brings it into existence?
4. Final Cause – Why does it exist? What is its purpose or goal?

We can consider the four causes of almost any object in order to sift through and clarify what we know about it. Take a saw, for instance, and consider its causes.

- The **material cause** of the saw is what it is made out of: the wood, metal, screws, and glue that make it up.
- The **formal cause** of the saw is what it is to be a saw: a tool used by humans for cutting materials by hand. The formal cause is often similar to a definition that might be given of a thing.
- The **efficient cause** of the saw is (a) the person who is using the saw at any given time or (b) the craftsman or machine that built the saw.
- The **final cause** of the saw is to cut things so that they are divided into pieces or made a certain size.

While the object in the case (the saw) is an artificial thing, the four causes are also present in natural things. The study of nature should include an investigation into all the causes of natural beings. When any of the four causes are ignored, the picture of nature that results is somehow incomplete or lacking. Keeping all four causes in mind helps us obtain a much more complete and well-rounded understanding of natural things. As lovers of wisdom, we should seek to know the deepest reasons *why* nature is the way that it is.

Below are the Greek terms that Aristotle uses to describe the causes, which you will need to know:

Material Cause	ύλη
Formal Cause	οὐσία
Efficient Cause	ἀρχή
Final Cause	τέλος

PRINCIPLES FOR OBSERVING LIVING BEINGS

"The sharp eye notes specific points and differences—it seizes upon and preserves the individuality of the thing..." — John Burroughs

1. Do not speak. Our senses are more awake and more receptive when we are quiet.
2. Look at what is actually in front of you, and ignore (temporarily) what you may know about the thing. Your knowledge can distract you from noticing what is right in front of you.
3. Look with focus and patience. Isolate one part or one quality of the thing at a time, and spend time observing it before your eye drifts to some other part or quality.
4. Make notes on paper about your observations while you are observing.

WHAT TO LOOK FOR

Proper Sensibles

- Colors and their shades
- Smells
- Sounds
- Tastes
- Textures, wetness/dryness, hot/cold

Common Sensibles

- Forms
- Shapes
- Patterns
 - Of color
 - Of texture
- Motion
 - Of the whole
 - Of parts in relation to each other and the whole
 - Natural/Unnatural
 - Externally caused/internally caused
- Behavior
 - Instincts
 - Habits
 - Use of senses

HETEROGENEITY IN ORGANISMS

As we have learned in our study of the heart, lungs, eye, and ear, the material parts of animals are wonderfully complex and diverse. When we observe living substances and their structures, we find that they have parts which are different from each other in kind, working together for the sake of the whole, of which they are parts. For example, our body is composed of different limbs and organs. Our feet are different from our hands, and our ears are different from our livers. Yet all these different parts seem to work in harmony with one another for the sake of the whole body. Proof of the fact that all the different parts have a share in the substance of the whole is easily found: when my hand is injured, I feel that "I" am injured. When my knee hurts, "I" am hurting.

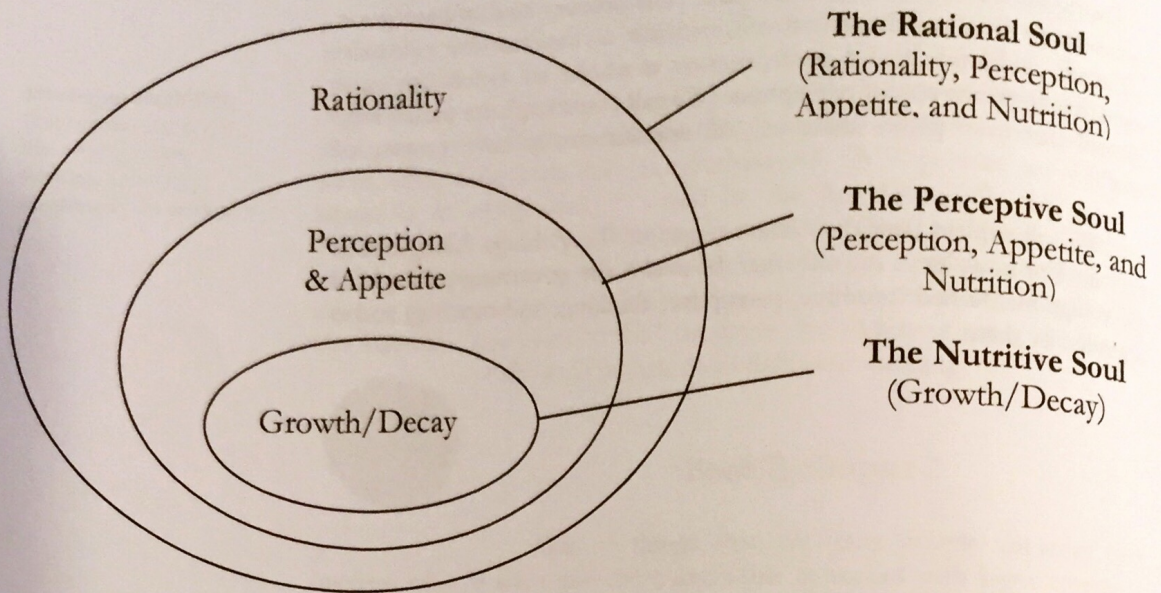
This condition of material bodies is referred to as *heterogeneity*. A part is called heterogeneous when it is composed of multiple material parts which are different in kind from other parts comprising the whole. The hand is heterogeneous – it is made of digits, bones, fingernails, blood vessels, skin, and hair, to name a few. If we look further into one of these parts, we find that they, too, are heterogeneous. For example, my skin is made up of a number of differently formed cells that perform different functions. The keratinocyte is structurally disposed to protect the cells found underneath, by forming a tough surface on the outside of the body. Beneath these are found a number of very elastic cells, among which we find the fibroblasts. These cells play a role in healing wounds quickly and help to form the constructive framework of the body.

So it seems that organisms are replete with heterogeneous parts. At the lowest levels, heterogeneous parts are composed of *homogeneous* parts. A part of a body is homogeneous when each of its parts are uniform, or the same in kind. Aristotle begins his *History of Animals* thus: "Of the parts of animals, some are simple: to wit, all such as divide into parts uniform with themselves, as flesh into flesh; others are composite, such as divide into parts not uniform with themselves, as, for instance, the hand does not divide into hands nor the face into faces." While Aristotle did not grasp the complexity of the parts of flesh (skin) described above, we can still see how flesh is apparently homogeneous.

In reflecting on heterogeneity, we can observe something profound and distinctive about living beings. Without heterogeneous parts, living beings could not be born, grow, and move themselves, i.e., be capable of self-motion. Each distinct part makes possible the life of the whole through its specific function, the work it does. In other words, each part has the health and virtue of the whole body for a final cause. This is why complex parts of bodies are called *organs* (*οργανος*, which means "instrument, tool") and why living beings are called *organisms*.

This relationship between organs and organisms draws us to reflect on another part/whole relationship. Just as the unique parts of the body are oriented towards the health of the whole body, so also are individual persons – united by a common human nature – oriented towards the same end. Of course, the greatest difference in this analogy is the fact that we, as living substances and persons, are not physically parts of a larger body, but are free and self-determining with respect to our efficient causes. This is not true of the parts which make us up. One of the greatest of human intellectual and moral activities (if not *the* greatest) is our attempt to better understand man's final cause.

KINDS OF SOULS AND THEIR POWERS



The diagram above shows the powers of the soul Aristotle discusses in Book II of *On the Soul*. The higher kinds of souls contain the powers (abilities) of the lower kinds and more. The perceptive soul contains the power of nutrition within it, since animals certainly eat and nourish themselves in addition to perceiving. The rational soul contains within it the powers of perception and nutrition, for man is also capable of sensing and growing like other animals. The souls are traditionally named according to their highest power.

One important point to note is that each living thing has only one soul. Man does not have three souls; he has only one. Since the soul is the source and cause of life in living things, to think that a man or a dog has multiple souls would be very much like saying that he has multiple lives. But this is an offense to reason. The soul is what unifies, directs, and forms all the parts and powers of a living thing such that it is a single, organized whole.

What about the ability to move oneself from one place to another, called locomotion? While most animals have the power to locomote, not all animals have it. Some plants also seem to behave as though they are moving from place to place. We cannot, therefore, use locomotion to distinguish animals from plants. Nonetheless, an animal's ability to locomote seems closely related to all its other powers: when an animal *perceives* food at a distance and *senses* its own hunger, how fitting that it also has the power to *traverse* the distance in order to *nourish* itself.