

THE EXTERIOR SENSES AND THEIR OBJECTS

Aristotle says that we take delight in our senses and, most of all, in the sense of sight. When we see things, what exactly are we seeing? When we sense things using any of our five senses, what is it about the object that we are sensing?

Take a look at a round object in front of you. Can you see the back side of it from your perspective? If you are careful, you realize that you cannot actually see the other side even though you may know what it looks like. Hence, your vision of the object does not completely capture the entirety of it. Further, your eyes cannot capture the smell or the taste of the object, even though it surely has a certain odor and flavor. Rather, what you see is the only visible qualities of it from one perspective.

This realization may give us a clue about what we are encountering when we use our senses. While we do recognize objects as wholes—whole people, trees, or dogs, etc.—our individual senses first sense the *properties* of these objects, properties particular to each of our five senses. The size of a person, the shape of a tree, and the texture of the dog’s fur are what we first encounter through our senses.

Properties, of course, are always properties of a particular thing or body. In the Western tradition, these “things” are known as *substances*. Properties exist in substances. When we say,

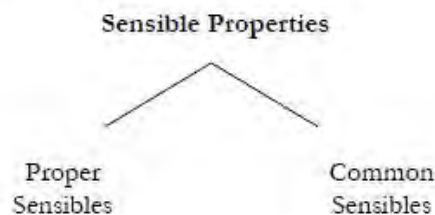
This tree is *brown*.

we are saying that the property of brownness is present in the tree, which is the substance. It would not make any sense to say,

This *brown* is tree.

Properties are present in substances and dependent on substances for their existence. Substances, however, have independent existences. Properties are also called *accidents*, which is a technical term describing anything that is dependent on a substance for its existence, but is not itself a substance.

There are two different kinds of properties that can be sensed: *proper sensibles* and *common sensibles*. Proper sensibles are properties that can be sensed by only one sense. Common sensibles are properties that can be sensed by more than one sense.



PROPER SENSIBLES

Each of our five senses is designed to take in a different quality of bodies. Through our sense of sight, we encounter the quality of *color*. Through our sense of smell, we encounter the quality of *odor*. Through our sense of hearing, we encounter the quality of *sound*. Through our sense of taste, we encounter the quality of *flavor*. Finally, through our sense of touch, we encounter the qualities of *texture, heat, cold, moisture, dryness, heaviness, lightness, hardness*, and perhaps others. The sense of touch is unique, because through it we can experience several different qualities of bodies.

Each of these qualities (*color, odor, sound, flavor, texture, heat, cold, moisture, dryness, heaviness, lightness, hardness*) is *proper* because only one particular sense can grasp it. For instance, colors cannot be felt or smelled or heard or tasted—they can only be seen. In the same way, textures cannot be seen or smelled or heard or tasted—they can only be felt. These qualities are traditionally known as *proper sensibles* because they can only be sensed by one sense.

Color—sensed only by sight

Odor—sensed only by smell

Sound—sensed only by hearing

Flavor—sensed only by taste

Texture, heat, cold, moisture, dryness, heaviness, lightness, hardness—sensed only by touch

COMMON SENSIBLES

Some qualities can be grasped by more than one sense, and these qualities are called *common sensibles*. Imagine you are trying to figure out the shape of a football. How many ways are there to figure out its shape? You can discover its shape by holding it in your hand or even by simply looking at it. So, *shape* is one of the common sensibles.

Motion, rest, number, size, and shape are all considered common sensibles. The common sensibles have an important relation to the proper sensibles. The proper sensibles make it possible for us to sense the common sensibles. For instance, with the eye we can see the size of a thing because of its color (a proper sensible). Likewise, with the hand we can detect the shape of something through its texture. Thus, the proper sensibles serve as a window through which we know the common sensibles.

Motion

Rest

Number

Size

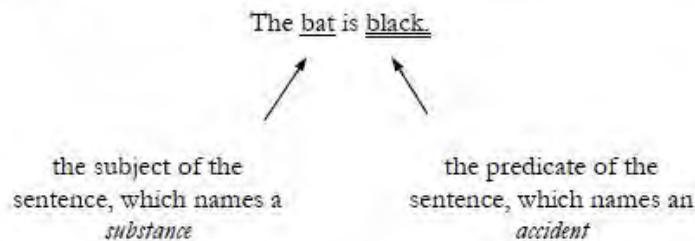
Shape

THE TEN CATEGORIES

Properties, as you have learned, are *accidents* that exist in *substances*. While a property is not a substance in itself, it is still a certain kind of being. There are ten kinds of being or categories of being, which Aristotle wrote about in his *Categories*. When we look at something and ask, “What is it?”, there are ten kinds of answers that can be given to the question. These ten kinds of answers reveal ten ultimate categories of being:

- | | | |
|----------------|---|------------------|
| 1. Substance | } | Accidents |
| 2. Quantity | | |
| 3. Quality | | |
| 4. Relation | | |
| 5. Action | | |
| 6. Passion | | |
| 7. Time | | |
| 8. Place | | |
| 9. Position | | |
| 10. Possession | | |

The second through the ninth categories are all kinds of *accidents*. This division of the 10 categories into *substance* and *accident* is clear in our language. First, there are the things that we talk about (the grammatical subjects of sentences): lions, lizards, leaves, or bats, for instance. These are *substances*. But there are also the things we say about these subjects (the grammatical predicates of sentences): the lion is fierce, the lizard runs quickly, the leaf is smooth, or the bat is black. These things said about substances are most often *accidents*.



Substance – a being that exists in itself rather than in another being

Accident – a modification or attribute of a substance, which can only exist in a substance

There are nine different modifications or attributes of substances. These are the nine accidents of quantity, quality, relation, action, passion, time, place, posture, and possession. Accidents exist in and depend on substances for their existence. Colors, for instance, can't just exist by themselves. There is no separate thing such as whiteness, really—there are only white objects! Substances, however, exist on their own and do not depend on their accidents.

The word “substance” comes from a combination of the Latin verb *sto, stare*, which means “to stand” and the prefix *sub*, which means “under”. A substance, then, can be thought of as that which stands under or underlies the accidents of a thing. It is what holds together and unites accidental features.

The word “accident” comes from the Latin verb *accido, accidere*, which means “to happen”. The accidents of a substance, therefore, are features that *happen* to characterize a substance in particular times and circumstances. For instance, you happen to be sitting right now (position), but you could also be standing. *Accidere* even means “to fall towards”, which helps us remember that accidents “befall” or characterize substances, often in an arbitrary way.

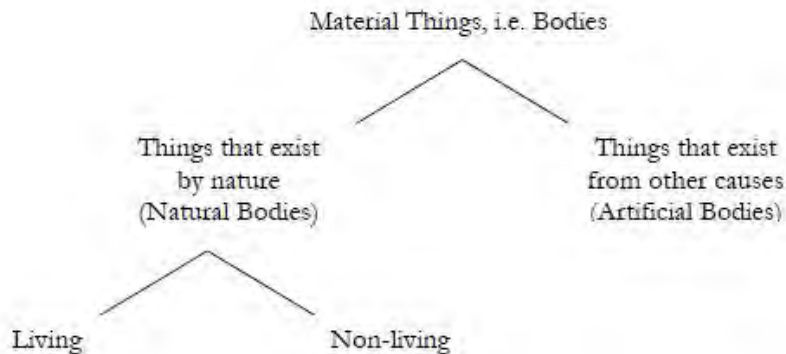
The chart below shows a set of questions that help to determine the different ways a thing exists:

Category	Relevant Question	Example
Substance	“What is the thing?”	The animal is a <i>dog</i>
Quantity	“How much is there of a thing?” “How many are there of a thing?”	There is <i>one</i> dog The dog is <i>small</i>
Quality	“What kind of thing is it?”	The dog is <i>brown</i> The dog is <i>hungry</i> The dog is <i>loud</i>
Relation	“How is the thing related to other things?”	The dog is <i>as big as</i> a horse
Action	“What does the thing do to other things?”	The dog is <i>barking</i>
Passion	“What is being done to this thing by something else?”	The dog is <i>being bitten</i>
Time	“When is the thing acting or being acted on?”	The dog is eating <i>today</i>
Place	“Where is the thing?”	The dog is <i>in the park</i>
Position	“In what position is the thing?”	The dog is <i>lying down</i>
Possession	“What does the thing have?”	The dog is <i>collared</i>

NATURAL THINGS & ARTIFICIAL THINGS

We began the year thinking about Aristotle's insight that all men *naturally* desire to know. Our desire for knowledge, he says, is clear to us because of the delight that we take in sensing. We used this as an opportunity to look more deeply into the nature of our senses. We looked first at *what* it is that we sense (qualities) and how these sensible qualities are accidents of material substances. After learning about *what* we sense, we turned to readings about *how* to sense—how to develop habits of attentive and receptive seeing. Burroughs, Thoreau, and Dillard model this art of seeing in their writing on nature and give us directions for how to practice this art. Most recently, we compared the sense of sight and the sense of touch with the help of DeKoninck. DeKoninck's essay reveals that our senses are not merely for knowing qualities, but ultimately for grabbing hold of reality itself, for encountering and knowing substances, through qualities.

The purpose of our scientific observations of nature is thus to know substances. But not everything we sense is a *natural* thing. Since natural science studies *natural* things, the observations of a natural scientist will be focused most of all on natural things. We will now study the difference between material things that are *natural* and material things that are not natural, which are called *artificial*, or manmade.



The tree above shows the main distinctions that Aristotle makes in Book II, Ch. 1 of the *Physics*. In order to understand what natural science studies, we must be able to tell the difference between natural things and artificial things, i.e. between nature and art. Anything that is made or arranged by man or some other animal is a product of skill. We say these things are products of art, and hence *artificial*. Anything that is not made by man or some other animal but seems to exist on its own, we tend to call *natural*. We recognize artificial things because they bear the mark of our skill or planning or intelligence. Natural things, therefore, can be identified by contrast to artificial things.

As an aside, artificial things seem to be made of natural materials. Consider a wooden chair: it is clearly a product of art, but it is made of something once living and natural. Even materials that are man-made, such as plastic, are made out of chemicals that are natural. Human art seems to be the

arranging and reforming materials that already exist—we cannot ultimately bring things into being. Art therefore builds on nature.

NATURAL THINGS HAVE NATURES

While it is important to be able to identify a thing saying, “This is artificial” and “That is natural”, identification does not represent a full understanding of the difference between natural and artificial things. So far, what we have said about natural things is negative – that they are “material things *not made by man*”. To better understand the subject of natural science (what it studies), we need to seek a positive definition of natural things.

The classical answer to what makes natural things natural is that they have *natures*. As you read in *Physics* II.1, Aristotle explains that natural things have “a principle of moving and of resting” within them and artificial things do not have such a principle. Aristotle also describes this principle as an “inborn impulse to change.” In both passages, he is describing a principle we call a *nature*. For instance, a tree grows leaves and bark on its own, but a wooden chair does not grow at all. The tree is the source of its own change, but the chair does not have such a power of change. We say that the tree is natural because it has a nature that causes its own growth. Not surprisingly, the word “nature” comes from the verb *nascor, nasci, natus sum*, which means “to be born”.

Living things clearly have this principle of motion, as we see through their growth. It is perhaps more difficult to see this impulse to change in non-living natural things, such as rocks, dirt, or water. Aristotle suggests in other passages that these non-living things have a natural, inward motion towards their natural places. We will discuss this in more detail in our study of physics.

The idea that non-living natural things have natural motions raises another question: what about artificial things made out of natural materials? For instance, how do we explain the motion of a wooden chair as it is falling off of a rooftop? Doesn't the artificial chair have a source of motion in it? Aristotle addresses this in the third paragraph of *Physics* II.1. The chair falls to the ground not *qua* chair, but *qua* wood. Why it falls is not because it is shaped as a chair, but because it is made out of wood. Hence, the motion is due to what is natural about the chair (its matter) and not what is a product of art (its shape).

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.

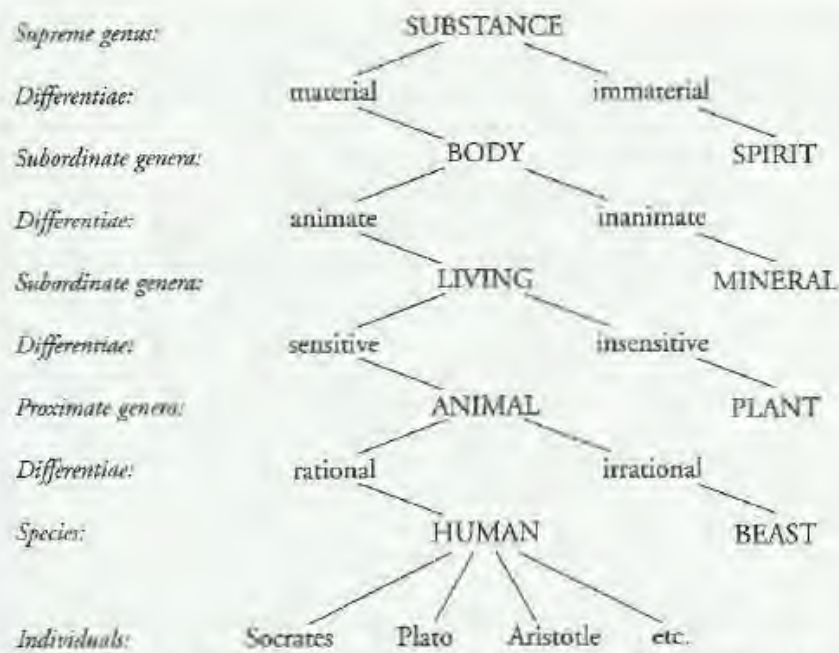


FIGURE 1.1 Tree of Porphyry, translated from a version by Peter of Spain (1239)

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.

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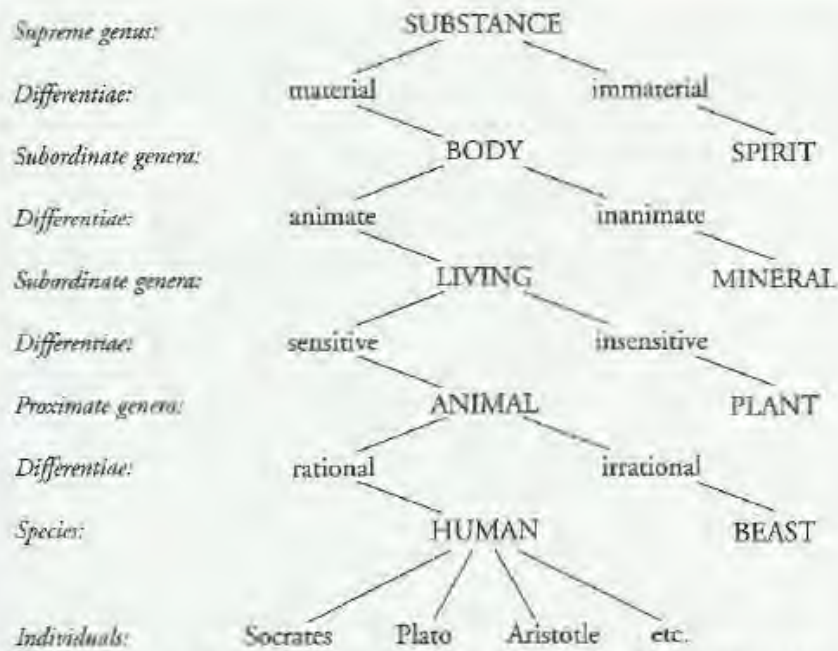


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Humans and beasts are in the genus of animals.

Animals are in a different genus than minerals because animals are living.

Species (from Lat. species, speciei, f., meaning “appearance, shape; kind”) – a class with only individual members within it.

Socrates and Plato are individuals of the same species.

Your dog and my cat are different species even though they are both animals.

Difference – what makes one species different from another in the same genus.

The differentia of humans is our rationality, since we are the only animals who can reason abstractly.

Living things and minerals have unique differentia because they are different species within the same genus.

Definition – a statement that expresses the nature of a thing through the combination of its nearest genus and its difference within the genus. (Definition = genus + specific difference)

Man is a rational animal.

Plants are insensitive organisms.

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.

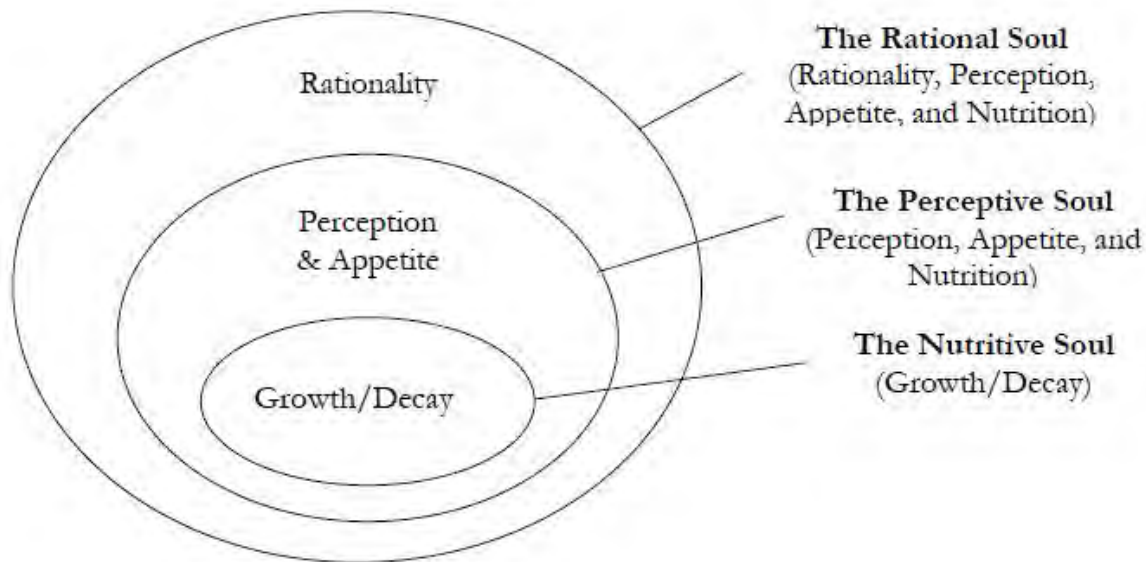
- The **material cause** of the saw is what it is made out of: the wood, metal, screws, and glue that make it up.
- The **formal cause** of the saw is what it is to be a saw: a tool used by humans for cutting materials by hand. The formal cause is often similar to a definition that might be given of 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	ούσία
Efficient Cause	άρχή
Final Cause	τέλος

KINDS OF SOULS AND THEIR POWERS

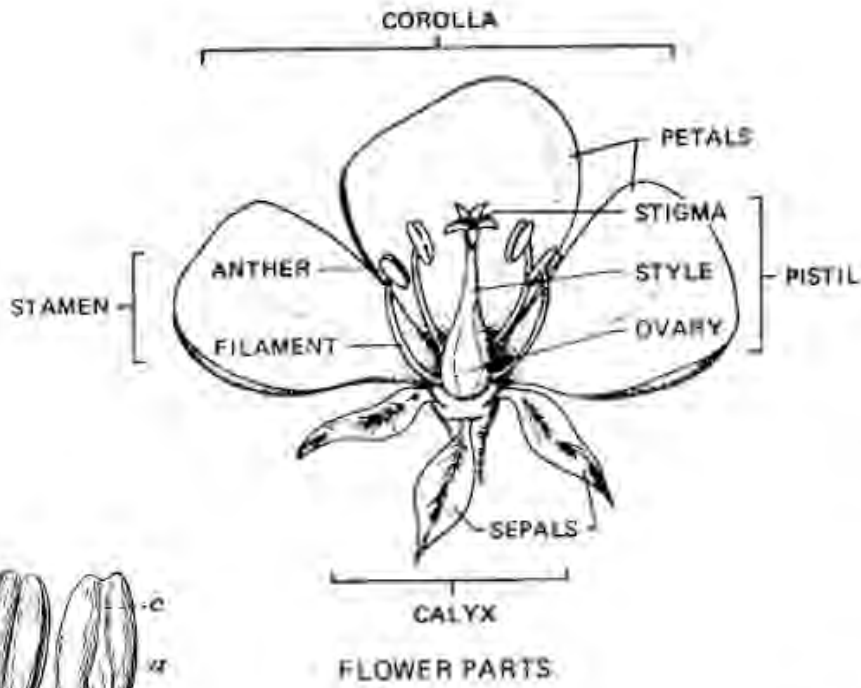


The diagram above shows the powers of the soul Aristotle discusses in Book II of *On the Soul*. The higher kinds of souls contain the powers (abilities) of the lower kinds and more. The perceptive soul contains the power of nutrition within it, since animals certainly eat and nourish themselves in addition 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.

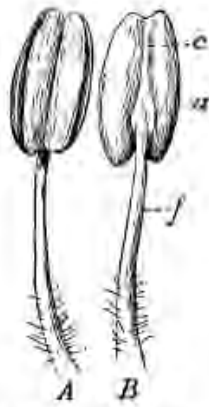
One important point to note is that each living thing has only one soul. Man does not have three souls; he has only one. Since the soul is the source and cause of life in living things, to think that a man or a dog has multiple souls would be very much like saying that he has multiple lives. But this 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.

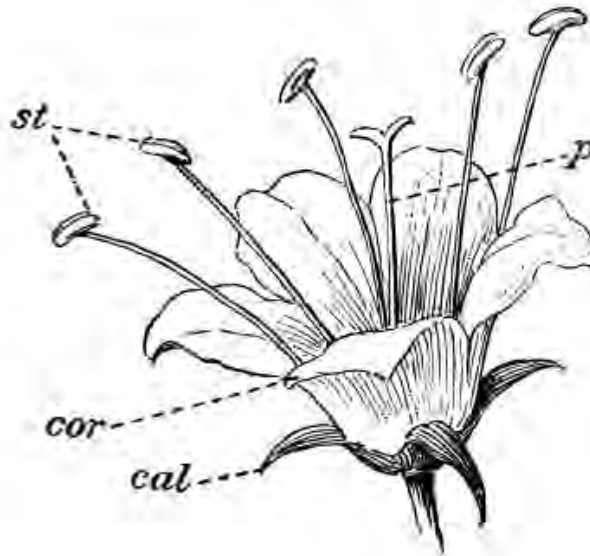
The Flower



Cross section of a pistil with eggs in the ovary



The stamen (*a* - anther, *f* - filament)



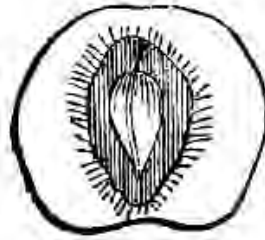
Flower Parts and their Purposes

1. **Calyx** – The outer, protective covering of the flower while it is a bud, which falls to the base of the flower after it opens and encircles the base.
2. **Sepals** – The individual leaf-like structures which together form the calyx. "*Separate petals*".
3. **Petals** – The flat, thin, colored structures surrounding the reproductive organs of the flower. The color of the petals often attracts insects and other pollinators to the flower.
4. **Corolla** – The whorl of flower petals as a whole, "crown" shaped.
5. **Stamen** – The male reproductive organ of the flower, composed of an anther and a filament. The stamen "stand" up from the base of the flower and typically surround the pistil.
 - a. **Anther** – This upper part of the stamen produces and stores pollen cells, which are the male reproductive cells of the flower.
 - b. **Filament** – The "thread-like" stalk that holds up the anthers of a flower.
6. **Pistil** – The female reproductive organ of the flower, centrally located within the flower. During pollination, pollen from a stamen is brought into contact with the pistil and then drawn into it. The pollen cells fertilize one or more ovum (egg), which grows into a new plant.
 - a. **Stigma** – The uppermost part of the pistil, often covered with a sticky residue which catches pollen on its surface.
 - b. **Style** – The pillar-like stalk that holds up the stigma and connects it to the ovary.
 - c. **Ovary** – As the main reproductive part of the pistil, the ovary is a chamber that produces and houses eggs along the inner surface of itself.
 - d. **Ovum** – One of the many female reproductive cells within the ovary of the pistil, known as the egg.

Pollination, Fruiting, and Germination

Pollination is the process in which pollen is transferred from an anther to a pistil in order to fertilize an ovum. The fertilized egg is called a **seed**, and the seed grows within the ovary of the flower. As the flower petals die, the ovary grows and forms a protective covering around the seed. Typically, it either swells and becomes fleshy or hardens around the seed. This swollen ovary is what is known as **botanical fruit**. In a variety of different ways for different plants, fruits serve as carriers and protectors of their seeds until the seeds find their way into the ground. When a seed becomes buried in the soil and sprouts roots, this is called **germination** – a new life taking root in order to grow into a mature plant.

The Variety of Fruit Forms



CLASSIFICATION OF FRUIT

Although flowers all have the same essential parts, different kinds of flowers vary greatly in shape, size, number and arrangement of parts, and so on. As you might imagine, knowing that every fruit develops from a flower, this variety in flowers leads to a variety in fruit. You already have some experience of this variety simply from being a consumer of fruit; you know, for example, that eating an apple is a very different experience than eating a banana or a blueberry. Looking at all of this variety amongst fruits, natural scientists have classified fruit into nine main groups.

Pomes

Perhaps the most common example of a pome is an apple. In fact, the word “pome” comes from the Latin word meaning “apple.” A pome is distinct from other kinds of fruit in that the fruit is mostly formed from the receptacle (under the flower) and includes not *just* the ovary, but also some of the surrounding tissue as well. A pome has a “core” of several small seeds, surrounded by a tough membrane, and the shriveled remains of the sepals, style, and stamens can sometimes be seen at the end of the pome, opposite the stem.

Drupes

Drupes are distinct from other kinds of fruit in that they always have a single seed with a hard outer layer, and that seed is surrounded by fleshy fruit. Think about a very common example of a drupe: the peach. If you have ever eaten a peach, you know that in the center there is a “pit” that you cannot eat. The pit is a hard, outer casing—formed from the wall of the ovary—with one seed inside.

Berries

You might be surprised to know that a tomato, a banana, and a bell pepper are actually berries, and that strawberries and raspberries are actually *not* berries. But do not be too alarmed by this: you have not been *wrong* about berries your whole life, you have just been speaking as an *eater* of fruit, rather than as a *scientist* of fruit. When natural scientists speak about berries, they mean something rather different from what my grandma means when she makes a berry cobbler. When you are cooking or eating, you use berry to mean a small, sweet or tart fruit, and we are not wrong to do so. Speaking as scientists, however, we use the word berry to refer to fruit having a distinctive structure and formation (rather than a particular kind of taste, as we do in the kitchen). Berries, according to the scientist, are fruits that develop from a single ovary and have two or more seeds. If you look at the inside of a tomato, you can see that the tomato fits this definition. There is a special group of berries, called *Hesperidium*, that include citrus fruits, such as an orange or a lemon.

Aggregate Fruits

The strawberry, which you might expect to be a berry because of its name, is actually an aggregate fruit. The reason for this classification is that, unlike berries which develop from a single ovary, strawberries form from many pistils within the same flower. If you looked at a strawberry flower, you would see many pistils. Seeds are produced in each of these pistils, and the fruit grows around all of them, joining together to form a single fruit. All aggregate fruits have this in common, that the fruit comes from a single flower with multiple pistils.

Legumes

Legumes are fruits that are usually dry or hard and that release their seeds by splitting along a seam that runs down the middle. Any kind of “pod” that is long and narrow and has seeds in a single-file line is probably a legume. Some common examples of legumes are beans, peanuts, and peas.

Nuts

Like the word berry, the word nut has both a culinary meaning and a scientific meaning. You have probably referred to peanuts and almonds as nuts, but, although that is true enough when you are cooking or eating, these do not fit the scientific meaning of the word *nut*. A nut, according to the scientific definition, is a dry fruit in which the ovary wall becomes a hard shell and the seed inside is unattached to it. An acorn is a good example of a nut—if you have ever shaken an acorn, you have heard and felt the seed moving around inside the hard outer shell.

Grains

Grains are fruit in which the fruit and seed are joined closely together. These fruits are typical of grass-like plants. Wheat and rice are good examples of grains.

Capsules

Capsules are actually the most common kind of fruit, although we probably do not think of them as fruit because we do not eat them. Capsules are dry fruit that form from pistils with compound ovaries, and which split open to release the seeds. Orchids, Cotton, Eucalyptus, and Horse Chestnut all have capsules.

Multiple fruits

All the fruits that you just read about above form from a single flower; multiple fruits are distinct from these because they actually form from multiple different flowers joined together. The most common example of a multiple fruit is the pineapple.

Illustration: From Flower to Fruit in Cherries

