Name ________________________________
Date ___________________ Hour _____

What is a scientific model?

What is the point of this reading?

- Models are ideas that scientists use to explain patterns they observe in the world.
- Models are judged to be acceptable or not based on how well they can explain and predict data and how consistent they are with what is already known about the world.
- Models are constantly being used to ask more questions about the world and when new data are gathered, models are revised or discarded altogether. Scientific knowledge is not static, but is always changing.

Throughout this semester, you will be making observations and looking at how evidence or data are connected. Explanations will be made from these patterns of data, and the explanations will be tested by talking through them and thinking about what makes sense. The story that makes the most sense will be your theory or model for what happened. This process – making observations, identifying patterns in data, and developing and testing explanations for those patterns – is quite similar to what scientists do as they develop explanations for natural phenomena. Such explanations are called scientific models.

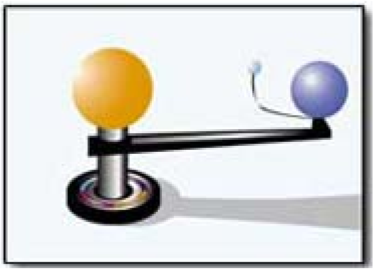
Scientists use drawings, graphs, equations, three dimensional structures, or words to communicate their models (which are ideas and not physical objects) to others. For example, a scientist might use 3-dimensional balls and sticks to help her communicate her ideas or model about molecular structure. Galileo developed a model to explain the patterns in the movements of objects in the sky, including the rising and setting of both the sun and moon. Currently, scientists are developing models to explain the phenomenon of uncontrolled cell division (or lack of "apoptosis" which is programmed cell death) associated with cancer. There are countless other important models already accepted by scientists and as many others that are currently being developed.

Why is scientific modeling important?

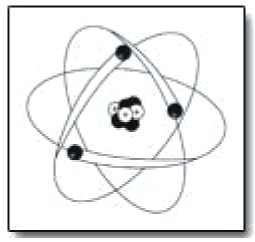
Most children like to play with models, including model cars, tinker toys, model houses, and so on. Likewise, most scientists interact with models. However, their model interaction is out of necessity (and maybe a bit of their childhood left in them!), as the forging of new science is frequently dependent on the development of models. Many times the system or object of a scientist's interest may be too small to be observed directly, like parts of atoms. Other objects may be inaccessible for direct visual study, like the center of the Earth or the surface of a distant galactic object. Other topics of study, such as gravity, magnetism, or thermodynamics, can be studied through their effects on matter. Because gravity, magnetism, and energy cannot be seen directly, they are also modeled. So a scientific model can be a scaled-down version or a scaled-up version of a natural object or system. New scientific discoveries and understanding frequently depend upon scientists developing scientific models and interacting with them.

Types of scientific models

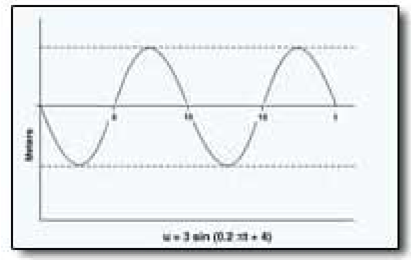
Scientists develop models in many different forms. Models may be actual physical constructions of mental images. They can also be mathematical models.



A model of the Earth, moon and sun, using wooden spheres that move mechanically, can physically model the phases of the moon and eclipses.



The mental models of early scientists pictured the atom as a solar system in which the sun modeled the nucleus and orbiting planets represented the electrons. Others models may be mathematical in nature.



Rays of light can be treated as waves and equations can be developed that graphically describe the properties of those waves in great detail.

How do you decide whether a model is "right"?

A community of scientists may have more than one model to explain a given phenomenon. Models are judged based on a number of factors:

- Can the model *explain all or most of the observations*?
- Can the model be used to *predict* the happenings of the system or event if it is manipulated in a specific way? For example, if a new piece of evidence is found, will your model still be the most likely story of what happened? Being able to correctly predict experimental outcomes is a powerful way of testing some kinds of models.
- Is the model *consistent with other ideas* we have about how the world works? Any models involving an invisible alien man who can do magic are automatically rejected on the basis of their absurdity: it is not realistic or plausible for such things to happen — even if it explains all the data.

Getting back to the question, "which model is right?" we have two important points to make: first, scientists don’t ask whether an answer is "right". *They ask whether a model is "acceptable"*. And acceptability is based on a model’s ability to do the three things outlined above: *explain, predict, and be* *consistent with other knowledge*. Second, more than one model may be an acceptable explanation for the same phenomenon. *It is not always possible to exclude all but one model* — and also not always desirable. For example, physicists think about light as being wavelike or particle-like and each model of light's behavior is used to think about and account for phenomena differently.

Do models ever change?

Absolutely!!! Your models for what is happening to produce the data patterns you see may change from one day to the next. As groups share ideas and new experiments produce new observations, the models you accept are often replaced or modified. The modified models are more acceptable to you because they are able to explain more data, are better able to be used to predict experimental outcomes, or are more consistent with other ideas.

Historically, many scientific models have changed a great deal in light of new data and new ideas. For example, at one time scientists thought that human sperm contained a tiny, pre-formed person (a "homunculus") and that the human egg was mainly a source of food for the developing organism. When more advanced microscopes made closer observations of sperm and egg possible, this model was discarded. The current model — in which both egg and sperm contribute DNA to the future organism — is better able to explain the fact that organisms inherit characteristics of both parents as well as observations of cellular mitosis.

Summary Questions:

1) In YOUR OWN WORDS write a few sentences describing what a scientific model is.

2) What are some important things a scientist looks for when she is judging the acceptability of a model? (Describe AT LEAST THREE.)

3) Give an example of a once-accepted model that was replaced by a revised model. Describe SPECIFICALLY why the model was replaced and why the new model is considered to be better than the old one (you may use an example from the article, from the modeling activity you did in class, or from another area of science).

Adopted from: http://www.wcer.wisc.edu/ncisla/muse/earth-moon-sun/materials/intro/material1D/activities/modelsHW.html