Activate Learning®

IQWST

# How Do I Develop and Use Models with Students?

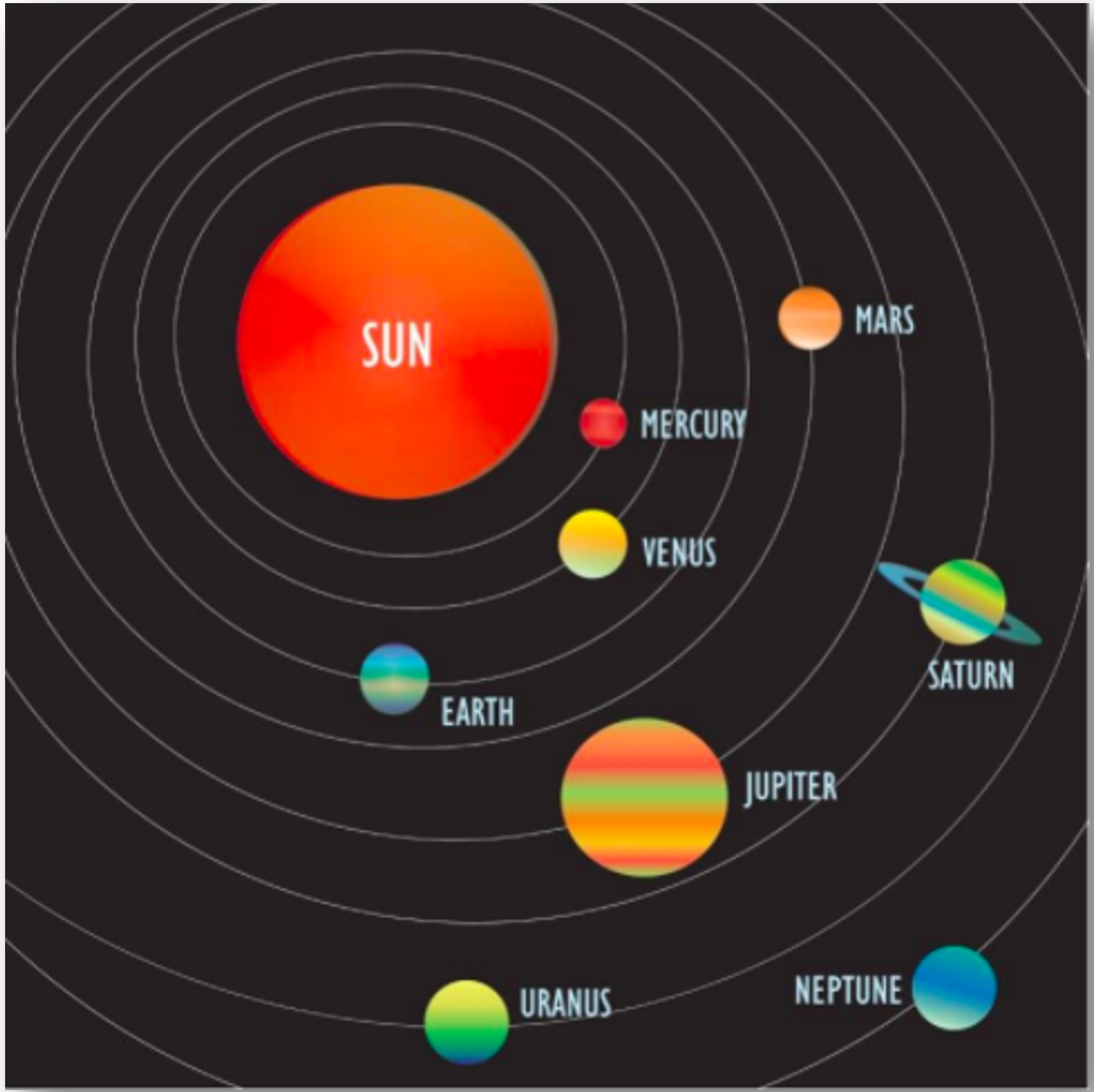
# What is a Scientific Model?

## Is this a scientific model?

A variety of possible models will be shown on the next 8 screens.

Try and figure out if they are models or not. Also, try and come up with a rationale for your answer.

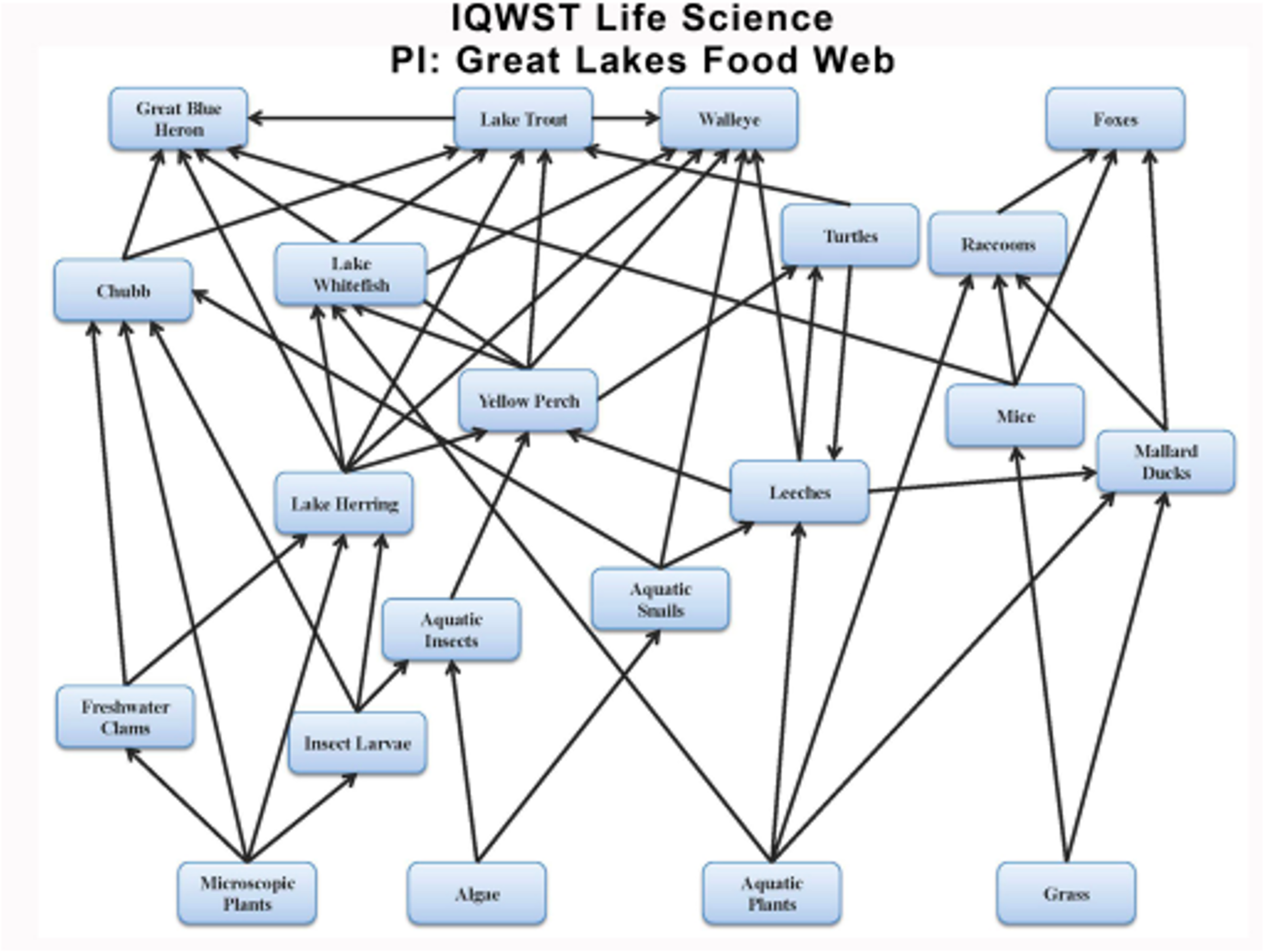
# Is this a Scientific Model?



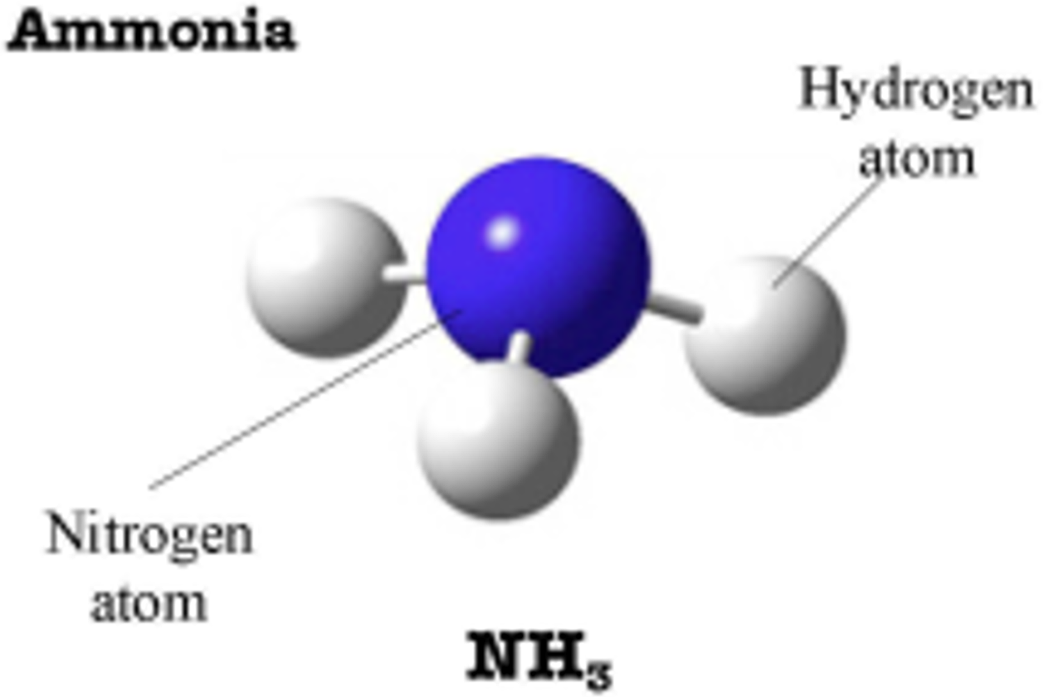

**What do you think about this diagram? Is it a scientific model?**

# Is this a Scientific Model?

**What about a food web?**
**Is it a model?**



# Is this a Scientific Model?



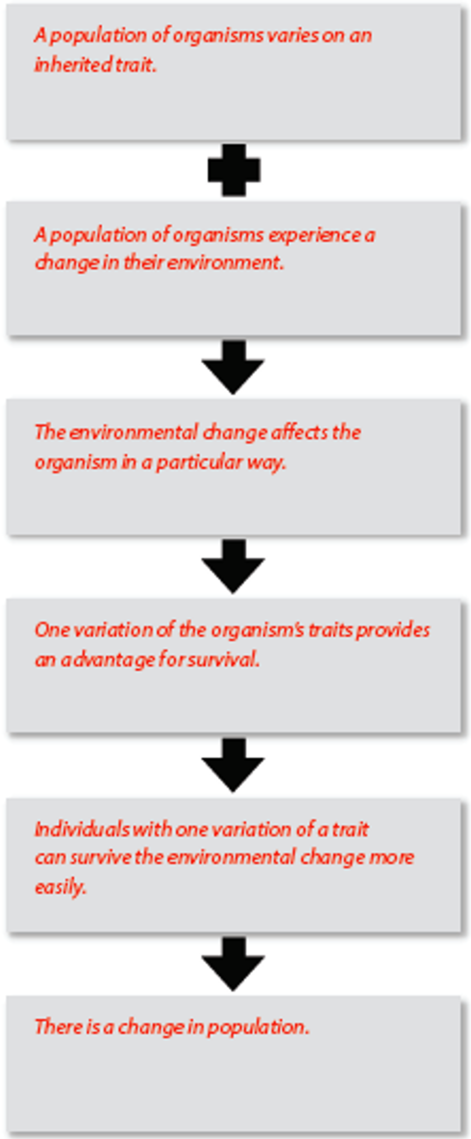

**Many times we see pictures or 3 dimensional objects of molecules. Are these models?**

# Is this a Scientific Model?


**Here is a diagram of the water cycle. Is this a model?**

# Is this a Scientific Model?

**How about words that describe natural selection? Is this a model?**



# Is this a Scientific Model?

**What about mathematics?**
**Can they be used a models?**

Eq. 1 was combined with the standard linear predictor in order to examine the effects of location, age, and sex on $p_{ij}$:

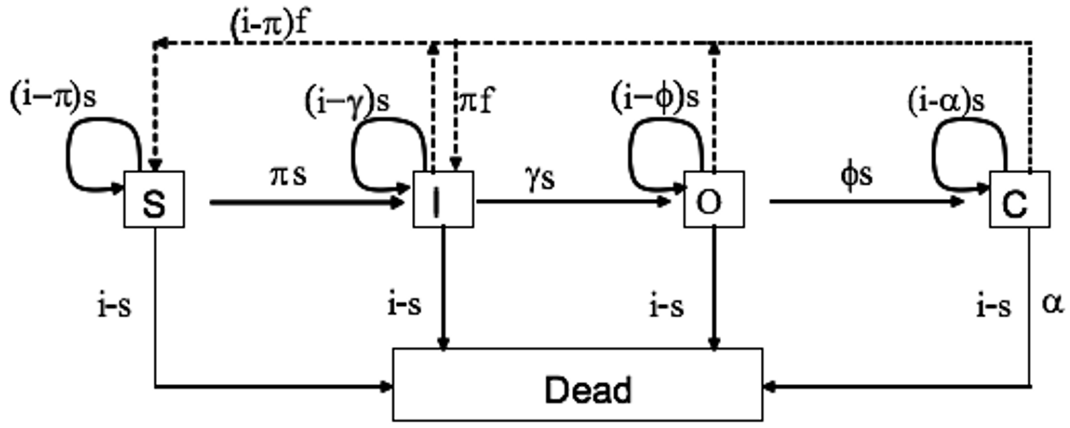
$$\mu_{ij} = \beta_0 + \mathbf{x}_{ij}\boldsymbol{\beta} + \alpha_i.$$

In this equation, $\beta_0$ is an intercept, $\mathbf{x}_{ij}$ is a row vector of covariate values for each individual animal $j$ at location $i$, $\boldsymbol{\beta}$ is the column vector of regression effects, and $\alpha_i$ is a latent spatial effect associated with location $i$. We fit various polynomial models of age and sex covariates (Table 1) to find the best parametric predictor for $p_{ij}$ (Set 1, Models 1.1–1.5, Table 1). We coded the sex effect to

# Is this a Scientific Model?

**Can models include both diagrams and math? This picture is about infectious transfer of chronic wasting disease in deer.**

Fig. 3




**S**: susceptible
**I**: Infectious (LN+)
**O**: Obex positive
**C**: Clinically ill

$\beta_a$: adult transmission sub-matrix
$\beta_m$: maternal transmission sub-matrix
$\gamma$: incubation sub-matrix
$\phi$: wasting sub-matrix
**s**: survival sub-matrix
$\alpha$: disease induced mortality sub-matrix
**i**: identity sub-matrix

# What is a Scientific Model?

- A set of ideas that explains how something in the universe works
- Accounts for all of the evidence
- Can be used to make predictions and explain natural phenomena

# Examples of scientific models are:

- **Model of the atom/particle model of matter**
- **Light ray model**
- **Water cycle model**
- **Food web models**
- **Computation models of the atmosphere**
- **Natural selection model**
- **Models of trout population in Lake Michigan**
- **Engineers use models for analyzing, testing, and designing**

# What ISN'T A Scientific Model or Scientific Modeling?

- **Scientific models are not ART projects!**
- **Art projects (e.g. jello models of the cell) serve a different purpose than models since they don't allow students to a consider how the model works taking the evidence into account.**
- **The model has to be useful for helping predict or explain a system. If the model is only descriptive and doesn't help to answer a question about how, or why, then it isn't a scientific model.**

# Five Qualities of Models

1. **They represent a process or <u>phenomenon</u> rather than things.**
2. **They can be <u>pictorial</u> – visually resemble the phenomenon/process (2D or 3D). They can also be words or mathematical.**
3. **They include both observable and <u>unobservable</u> features.**
4. **They should be <u>revised</u> as students gather new evidence from activities (must <u>“fit” the evidence</u>).**
5. **PURPOSE: They help us explain or predict how or why a phenomenon works or will work.**

# Progressions of Modeling from K-12 in NGSS

| Grades K-2 | Grades 3-5 | Grades 6-8 | Grades 9-12 |
|---|---|---|---|
| Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.<br>• Distinguish between a model and the actual object, process, and/or events the model represents.<br>• Compare models to identify common features and differences. | Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.<br>• Identify limitations of models.<br>• Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.<br>• Develop a model using an analogy, example, or abstract representation to describe a | Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>• Evaluate limitations of a model for a proposed object or tool.<br>• Develop or modify a model— based on evidence – to match what happens if a variable or component of a system is changed.<br>• Use and/or develop a model of simple systems with uncertain and less predictable factors. | Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.<br>• Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.<br>• Design a test of a model to ascertain its reliability. |

# Modeling in Middle School in NGSS

**These are the elements of modeling for Grades 6-8 from Appendix F of NGSS.**

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| Grades 6-8 |
| --- |
| Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.<br>• Evaluate limitations of a model for a proposed object or tool.<br>• Develop or modify a model— based on evidence – to match what happens if a variable or component of a system is changed.<br>• Use and/or develop a model of simple systems with uncertain and less predictable factors.<br>• Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.<br>• Develop and/or use a model to predict and/or describe phenomena.<br>• Develop a model to describe unobservable mechanisms.<br>• Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. |

# Why Engage Students in the Practice of Modeling?

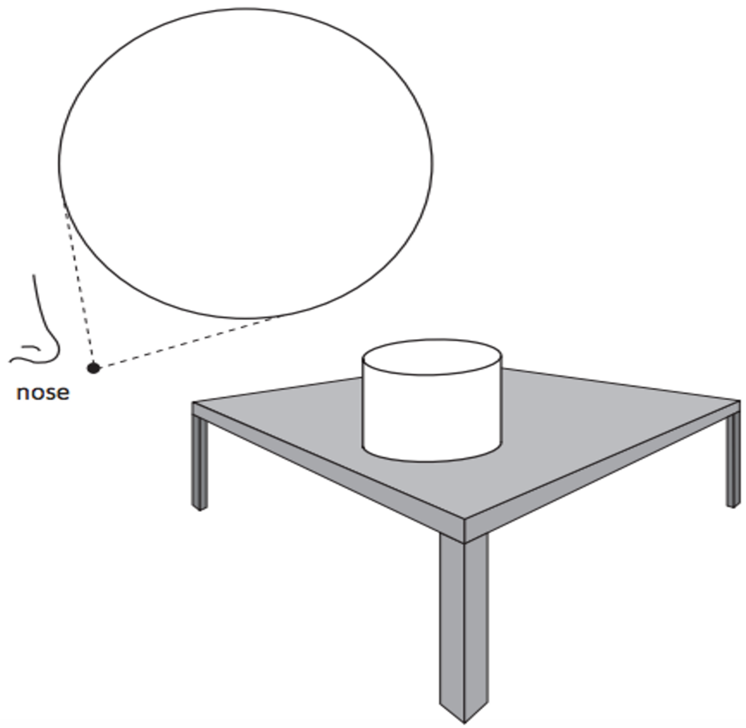
1. **To help learners understand the disciplinary core ideas. Models make invisible processes, mechanisms and components visible and testable.**
2. **Helps students to understand the way science works and functions.**
3. **Many of the science practices such as asking questions, argumentation and analyzing data are included when students develop models.**

# Developing Models and other Science Practices

- Scientists ask questions and plan and carry out investigations about phenomena to collect evidence to develop models.
- They then analyze and interpret data using mathematics and computational thinking that also help to develop the models.
- They use the model to construct explanations and engage in argument from evidence about different models.
- They then obtain, evaluate and communicate about models.

# Example: “How Can I Smell Things From a Distance?

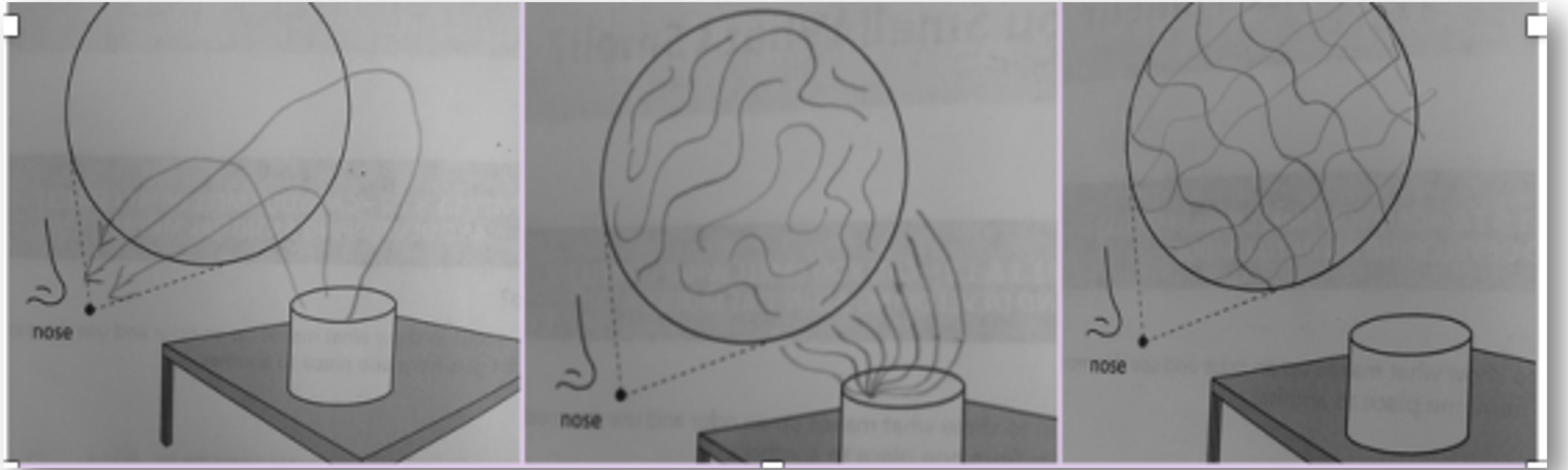
**Phenomenon to explain:** *How does the smell get from the container to your nose?*




- **A model can be used to explain something. How can your model help you explain how people smell odors?**
- **Describe what your model shows about odors.**

# Part 1: Evaluating the Initial Model

**What you might see:**

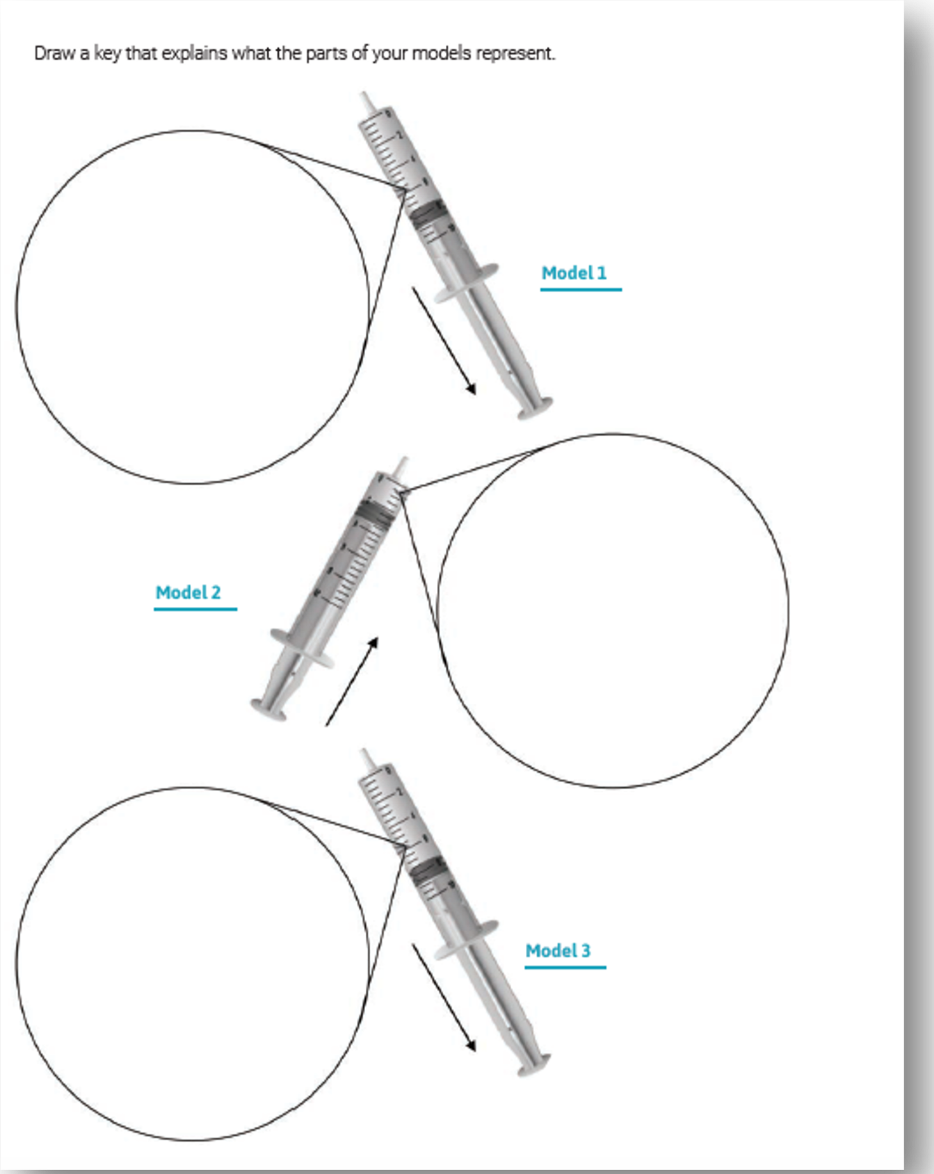


# Part 2: Revising our Model

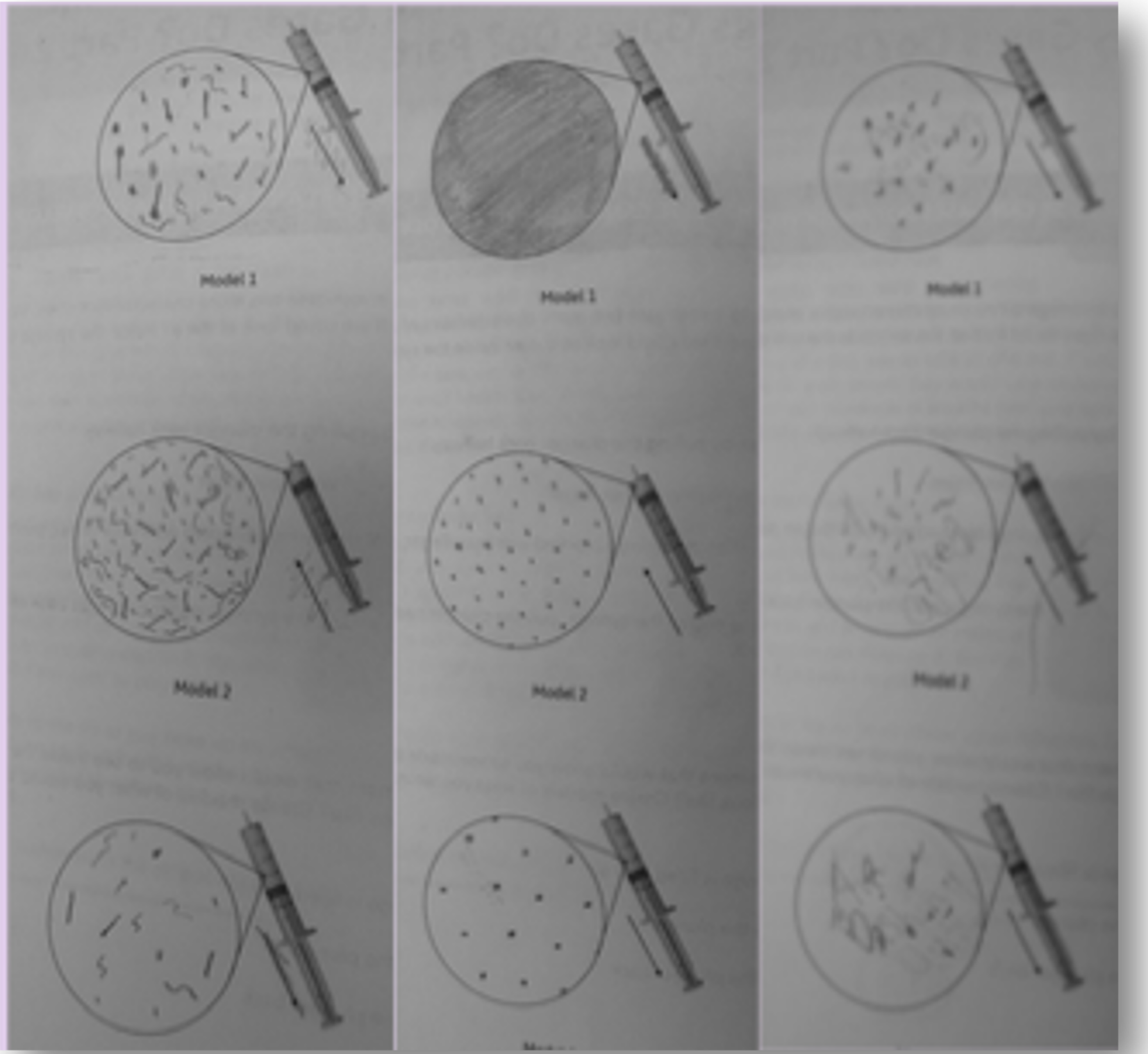
1. **Students are asked to develop a model that accounts for the new phenomenon.**
2. **At this point students have agreed from previous activities where they put air in a basketball that air has mass and volume.**
3. **They also agree that air does not have a definite shape or volume and can be added and removed after an activity of pumping air into and out of a flask.**

Students gather data about what happens with air in a syringe when they push in the plunger and then pull it out.

They draw a model to show what is happening.



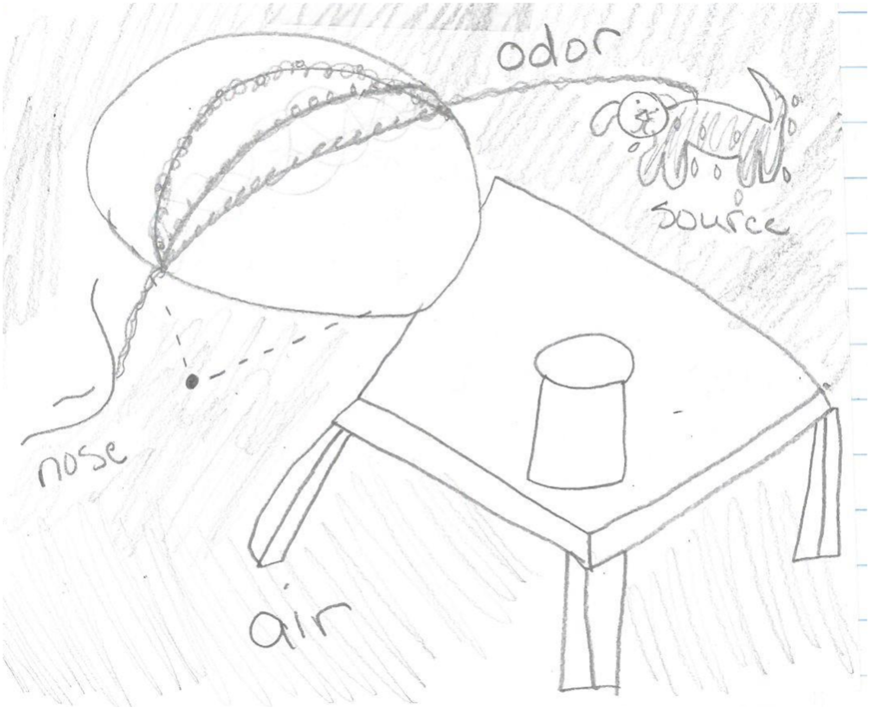
## Student Samples

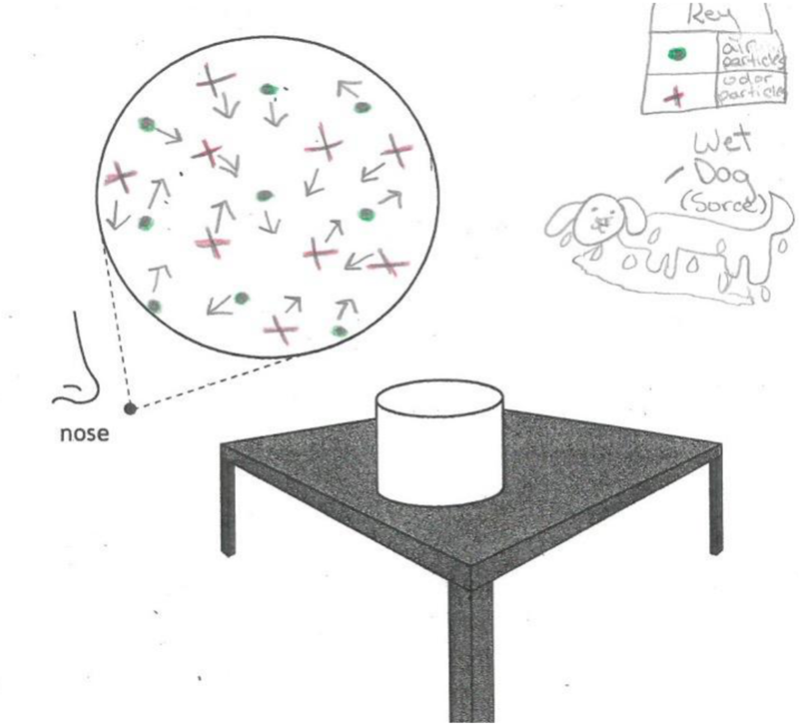


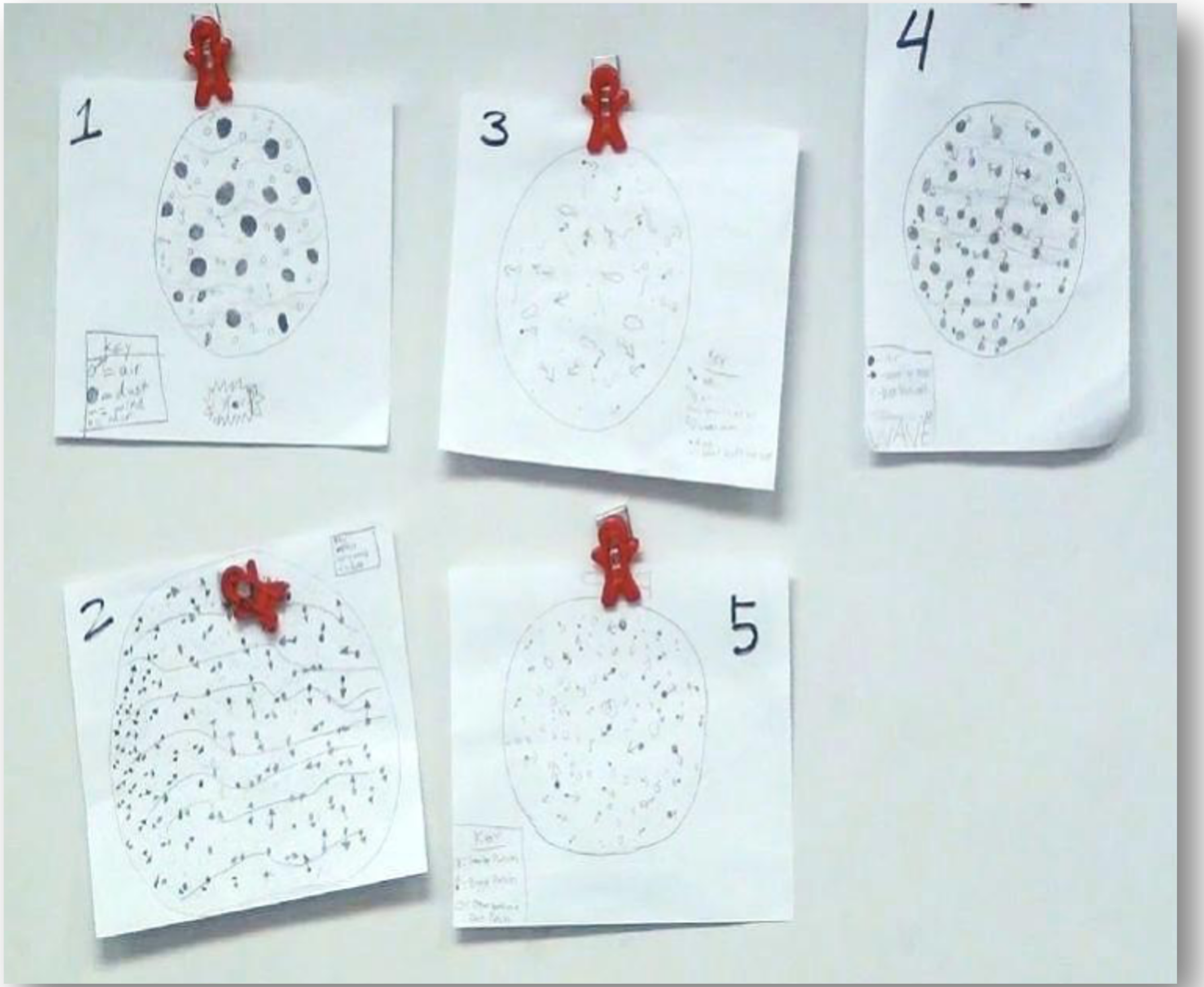
Misconceptions persist. But students are beginning to develop a model of the particle nature of matter. They are beginning to see gasses as a mixture of particles and empty space.

# After many other investigative activities:

**One student's  early and later models of the same phenomenon**



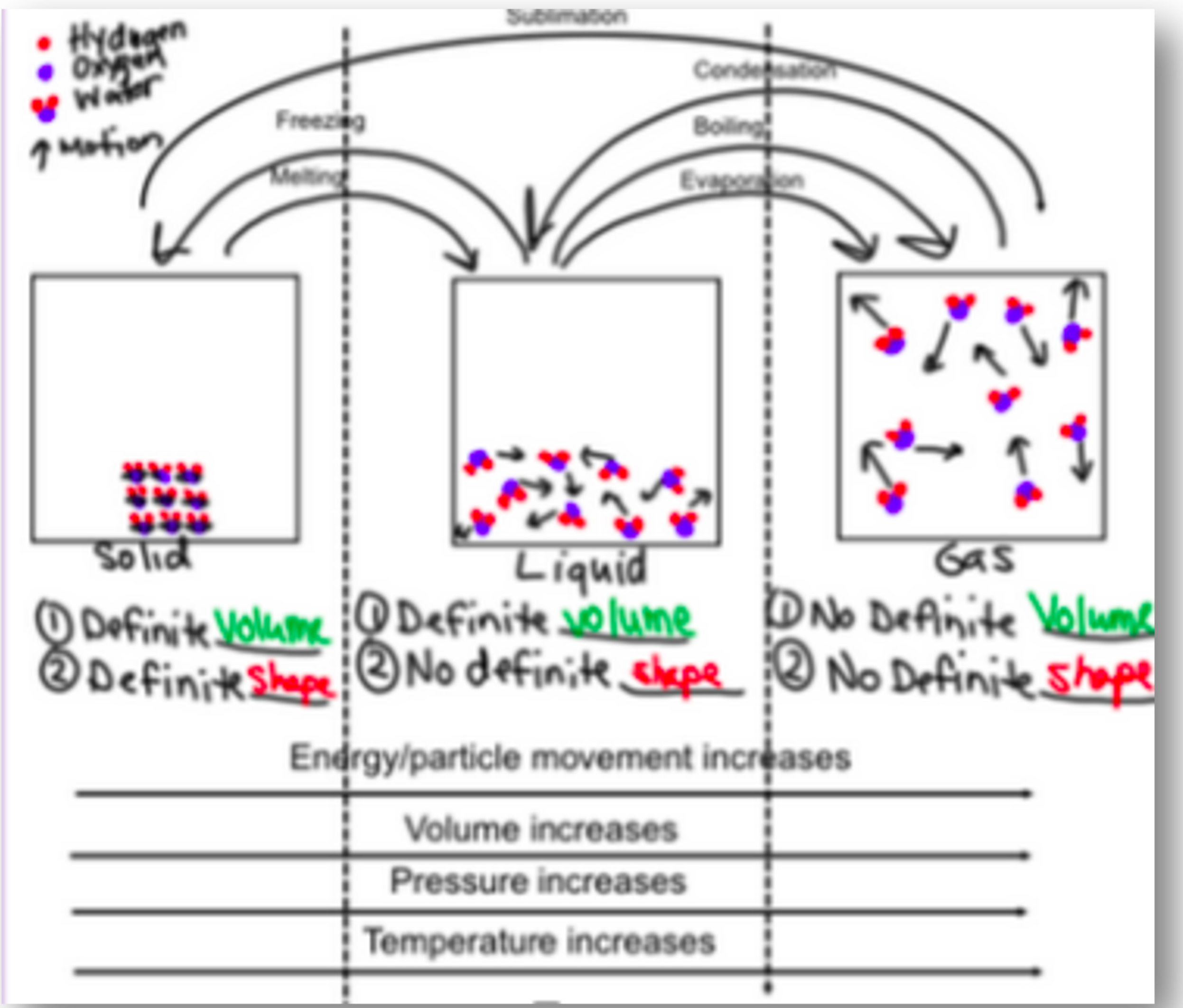






**Students develop and use models to explain and predict phenomena**

- Draft
- Share
- Give Feedback
- Receive Feedback
- Revise
- Present

# Final Consensus Model at the end of the unit

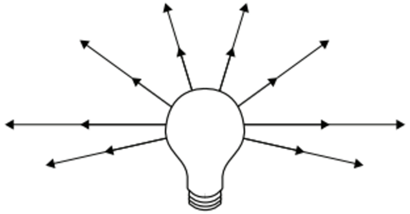


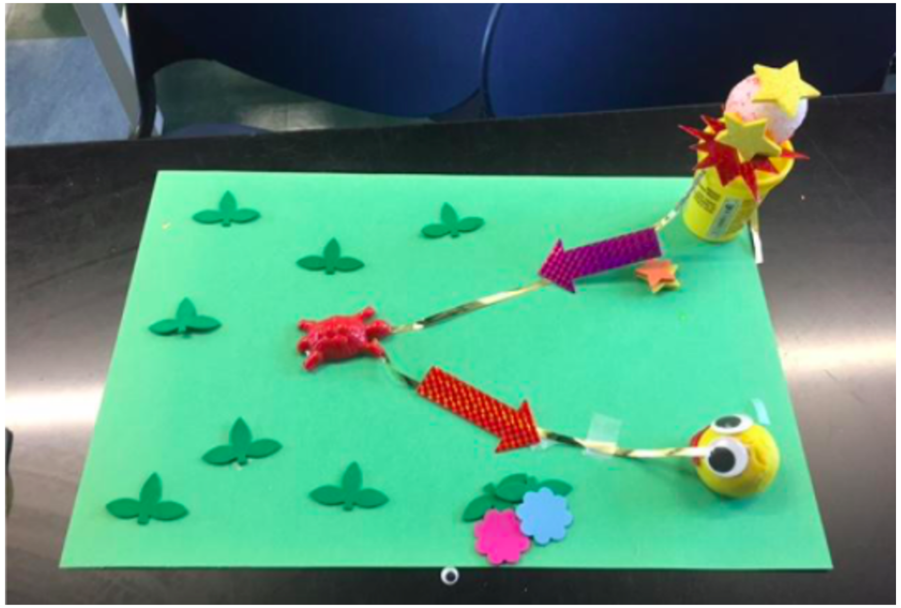
# Using the Model to Explain Novel Phenomena

- Students read about how some people spray coniferous trees with a skunk smell so that thieves do not steal them.
- They need to use the particulate nature of matter to understand this scenario and then create a brochure, advertisement, television or radio commercial, poster, or other representation of their understanding.

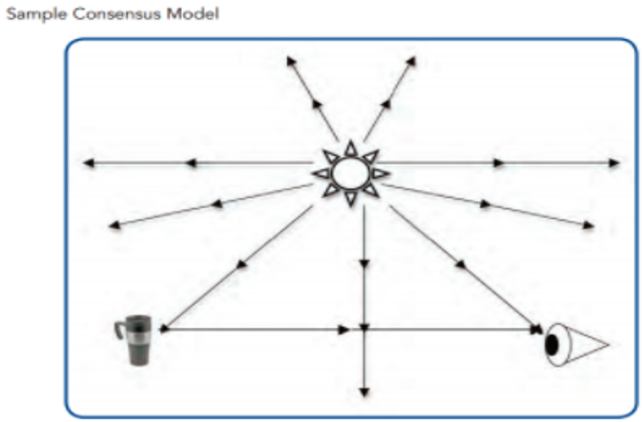
# PS1: How Does Light Allow Me to See?

**The models that students develop in this unit will help them to answer the question.**





Our Class Consensus Model

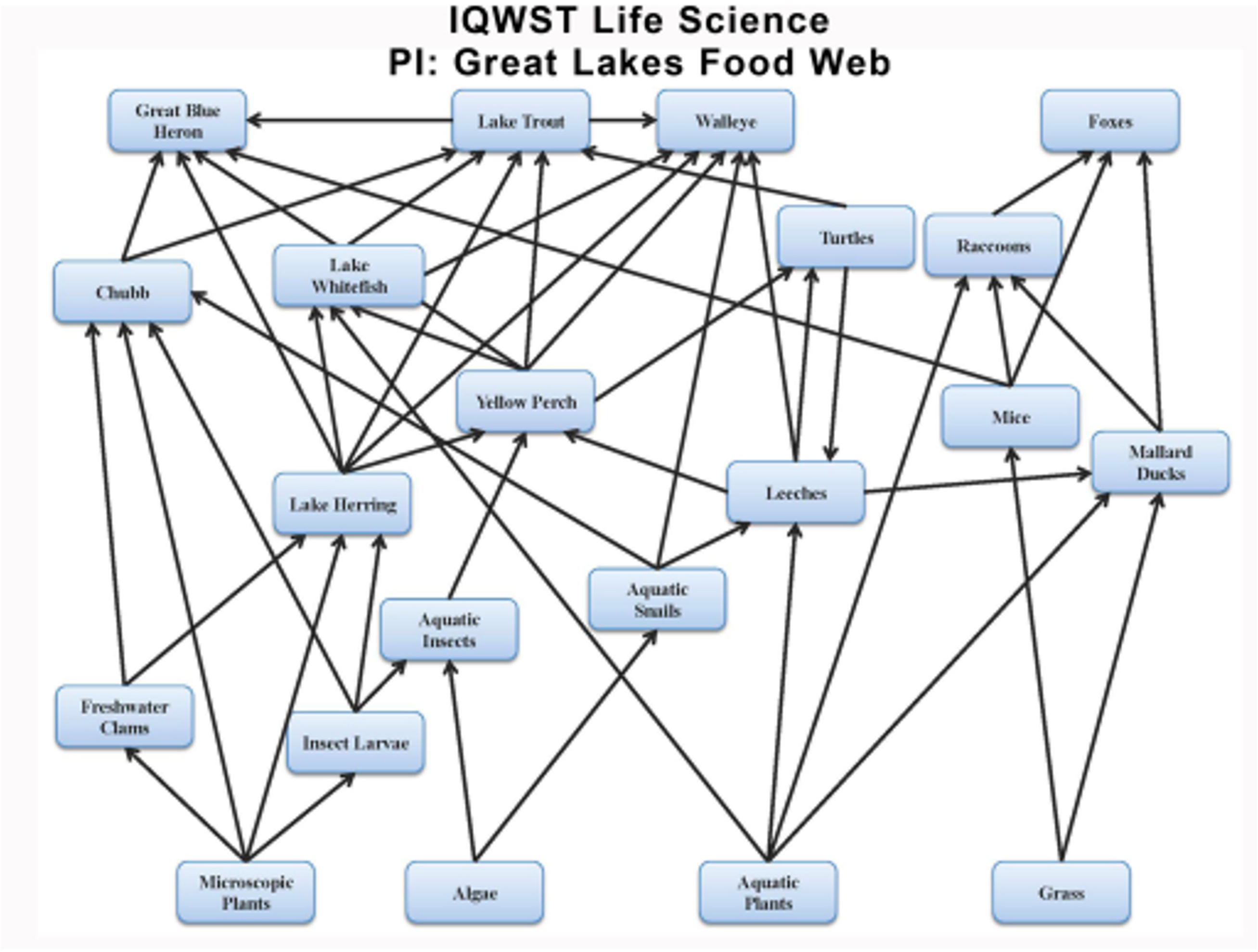


# ES1:  How Does Water Shape My World?

**Students use a model about water reservoirs and the water cycle, model a landform and use a stream table as a model of water movement.**

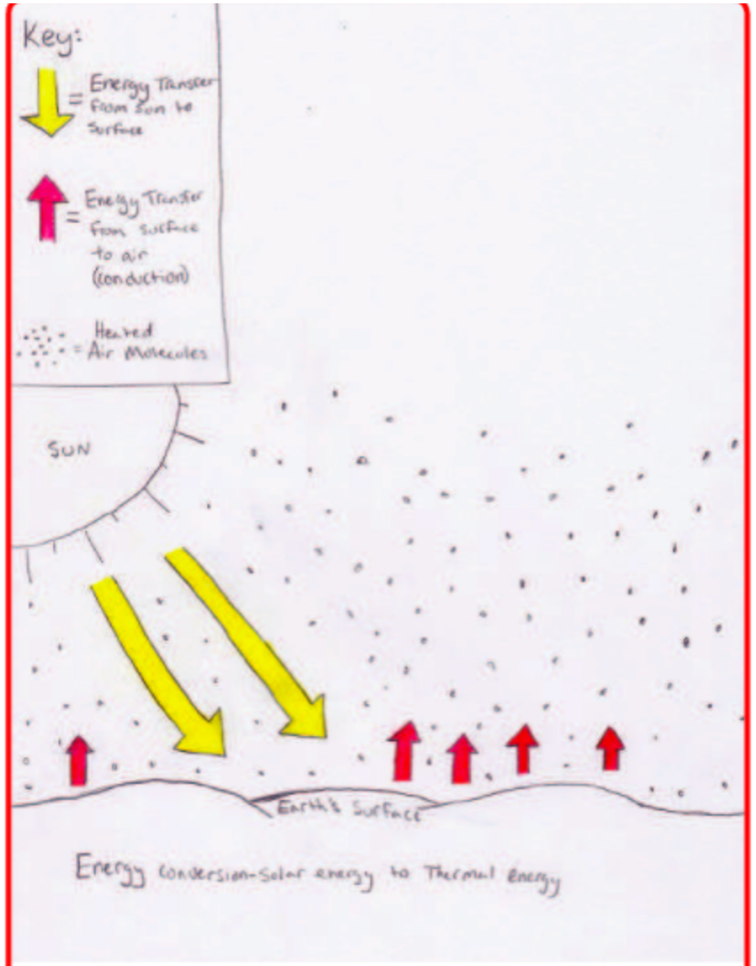
# LS1: Where Have All the Creatures Gone?

**Students use a food chain model to explain how lamprey get their energy from lake trout and it can decrease the population of trout.**



# ES2: What Makes the Weather Change?

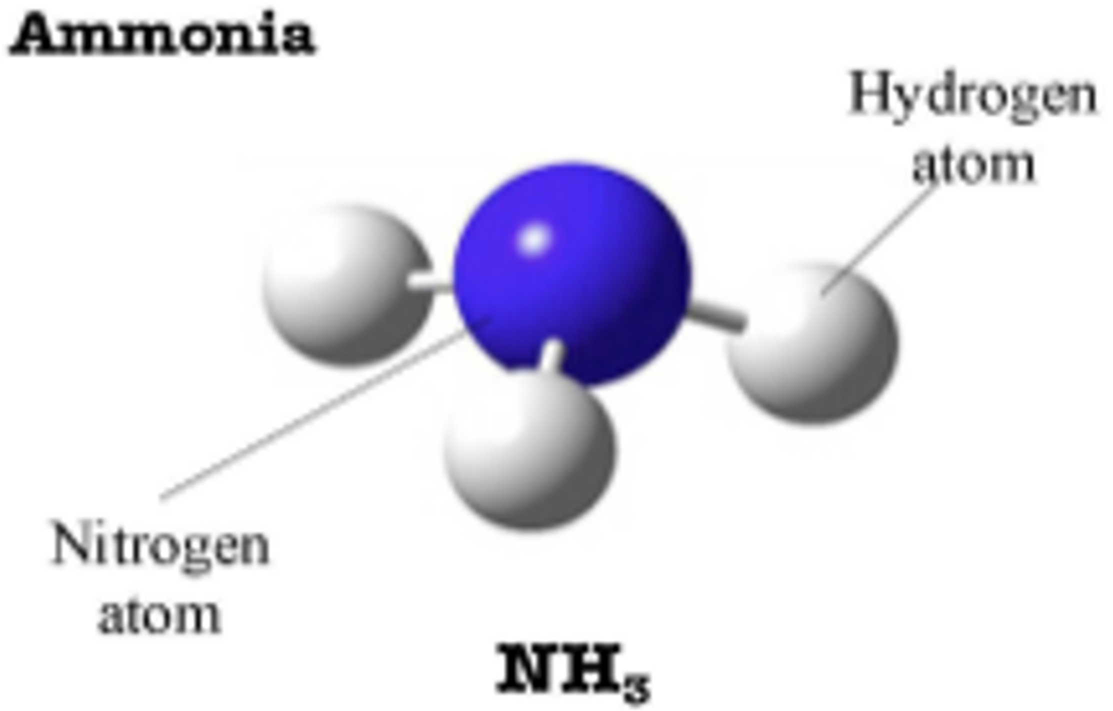
**Students draw models about how the earth is heated and then revise it after they figure out about conduction. They then use weather models to explain how storms happen.**




Sample Consensus Model

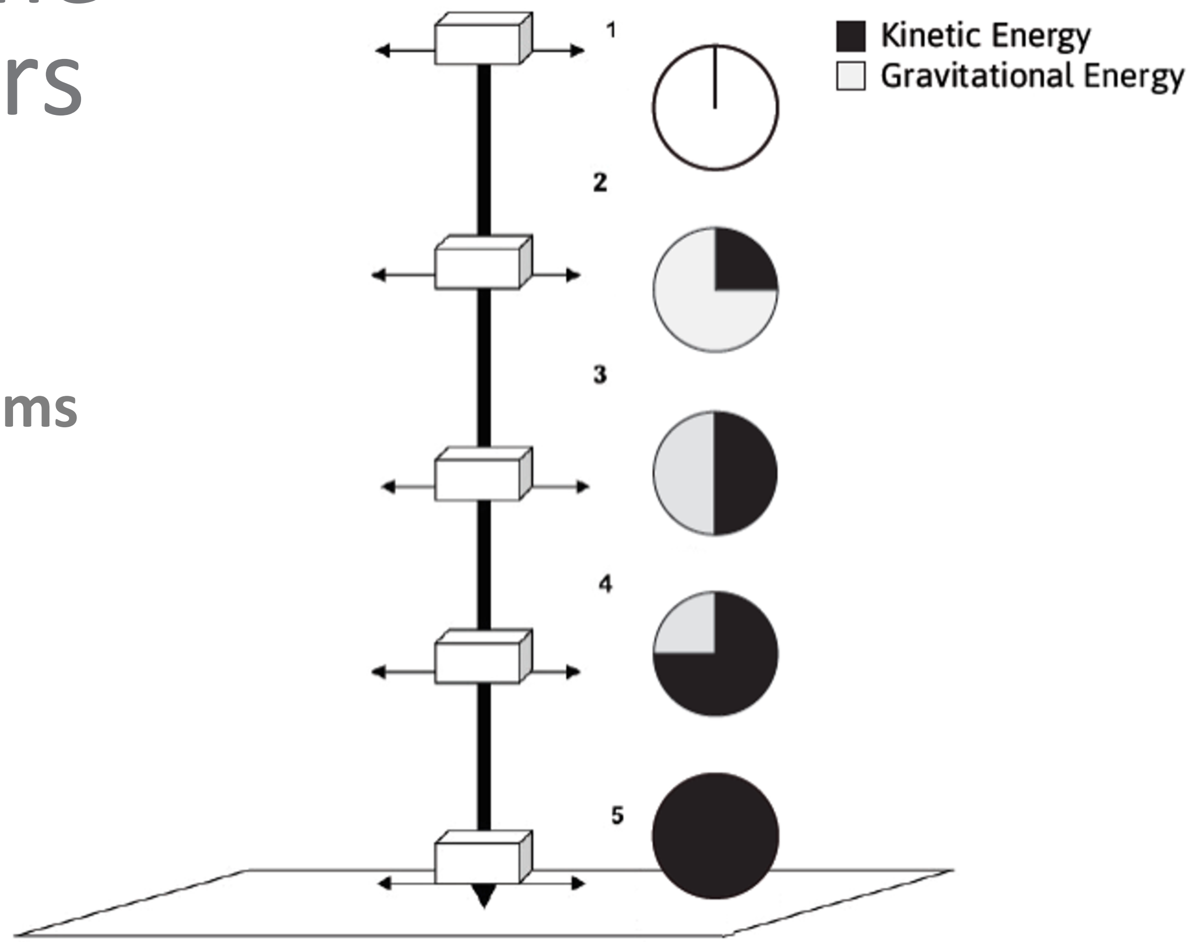
# IC2: How Can We Make New Stuff From Old Stuff?

**Students make models of molecules and use them to explain how chemical reactions occur.**



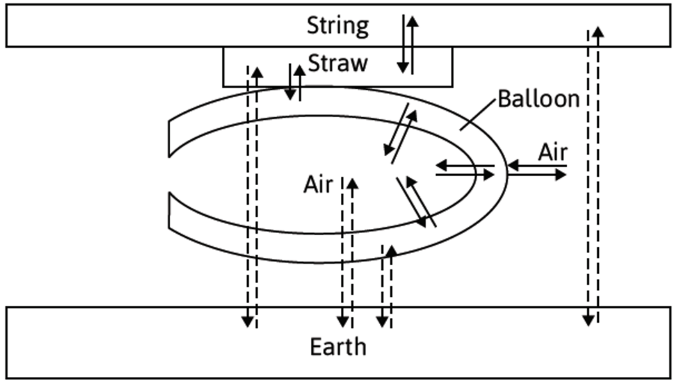
# PS2: What Makes Some Things Stop and Others Keep Going?

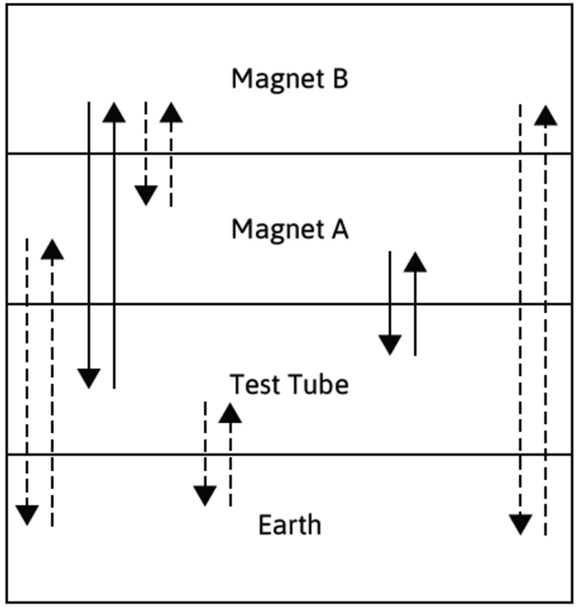
**Students use energy conversion diagrams as models to explain how energy is converted from one form to another.**

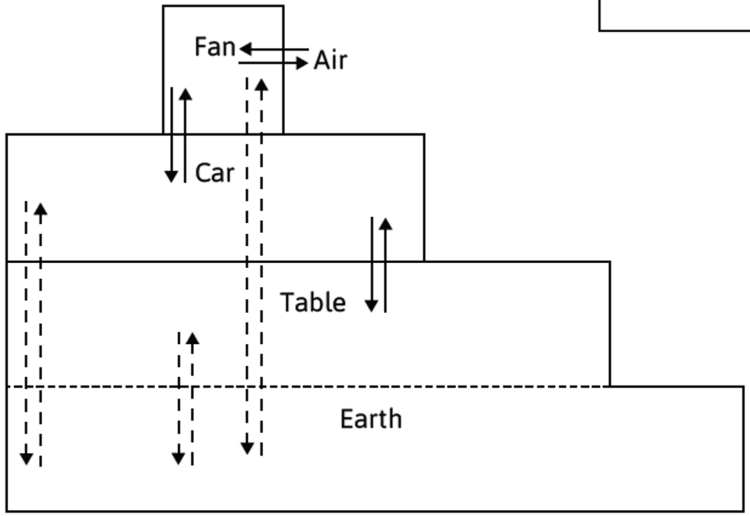


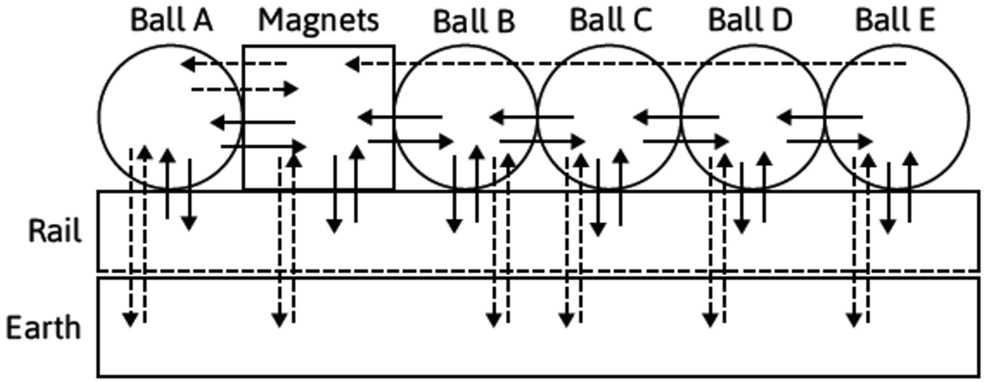
# PS3: How Will It Move?

**Students develop models to explain how each of the four devices at the beginning of the unit work.**



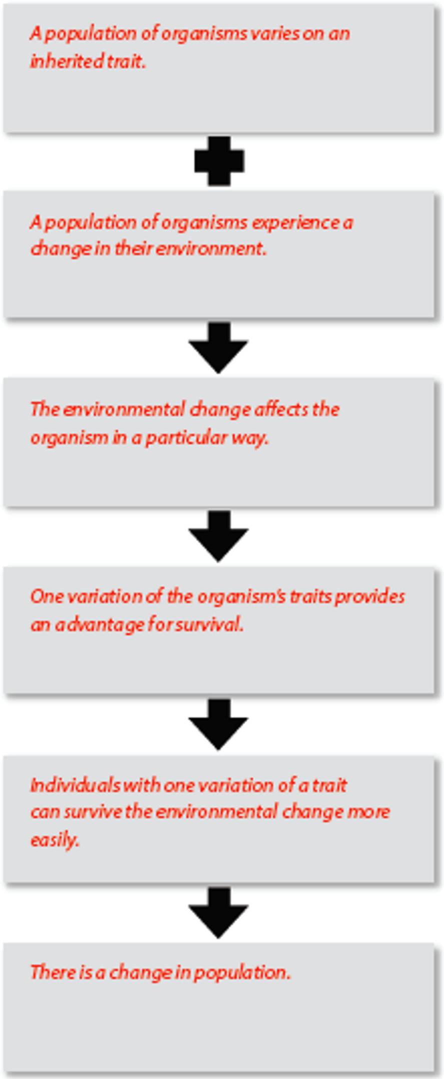



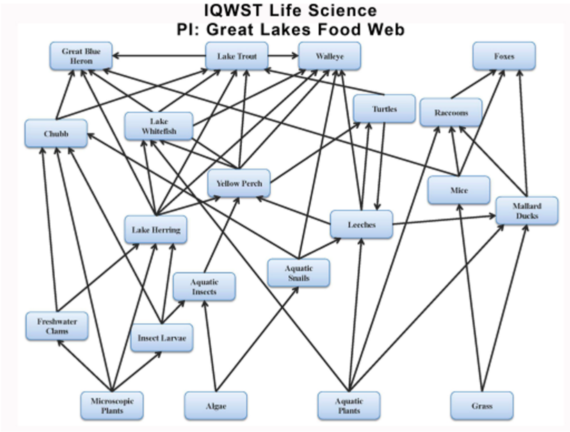



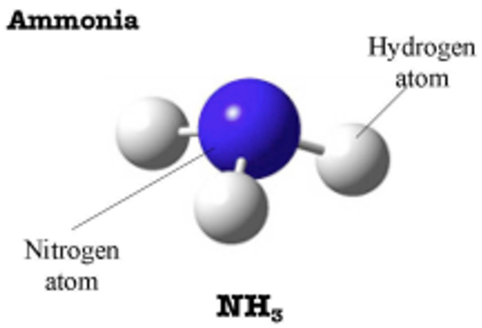



# LS3: Why Do Organisms Look the Way They Do?

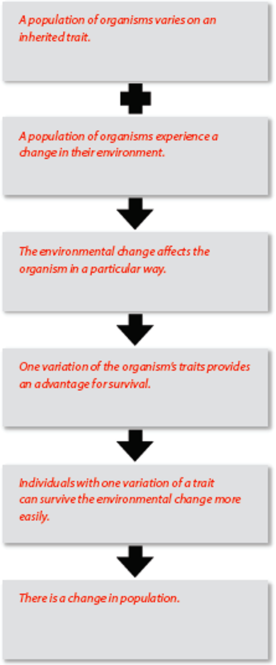
**Students develop models about inheritance and then examine data about Peppered Moths, Galapagos Finches and Bacterial antibiotic resistance to develop a model of natural selection.**







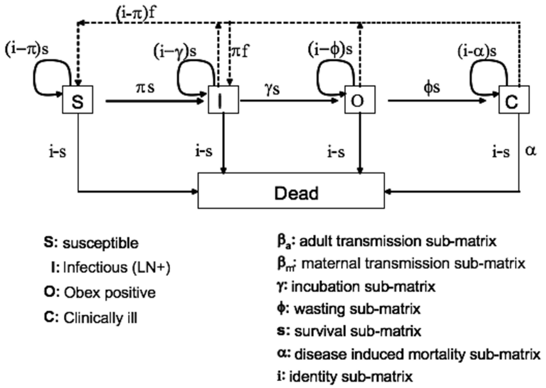



Eq. 1 was combined with the standard linear predictor in order to examine the effects of location, age, and sex on $p_{ij}$:

$$\mu_{ij} = \beta_0 + \mathbf{x}_{ij}\boldsymbol{\beta} + \alpha_i.$$

In this equation, $\beta_0$ is an intercept, $\mathbf{x}_{ij}$ is a row vector of covariate values for each individual animal $j$ at location $i$, $\boldsymbol{\beta}$ is the column vector of regression effects, and $\alpha_i$ is a latent spatial effect associated with location $i$. We fit various polynomial models of age and sex covariates (Table 1) to find the best parametric predictor for $p_{ij}$ (Set 1, Models 1.1–1.5, Table 1). We coded the sex effect to

Fig. 3




S: susceptible
I: Infectious (LN+)
O: Obex positive
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$\beta_a$: adult transmission sub-matrix
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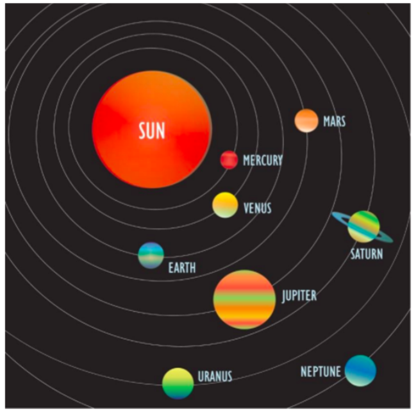

- So hopefully you can now see that how a diagram, three-dimensional object, math or words can be used as a model if it is used to explain and/or predict.

- The middle two were included on the previous page in this presentation just so you can see how professional scientists use models in many different ways.
    - Scientists ask questions about the models, use them to plan and then carry out investigations, construct explanations based on them, argue about them and write about them.

- Modeling is powerful to students to do so that they learn disciplinary core ideas and they learn how science works.