

Argumentation in Science Education

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A FRAMEWORK FOR K-12 SCIENCE EDUCATION

Building on What We Know

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A Model for Scientific Practices?





Science as a Set of Practices

1. Asking Questions & Defining Problems
2. Developing and Using Models
3. Planning and Carrying out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematical and Computational Thinking
6. Constructing Explanations & Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating and Communicating Information

Phenomena

Do it

Ideas

“The history of science in the European tradition is the history of vision and argument”

Learning Science

Construction

AND

Critique

**Knowing why you are wrong matters as
much as knowing why you are right!**

How do we know?

That Day and Night are caused by a spinning Earth

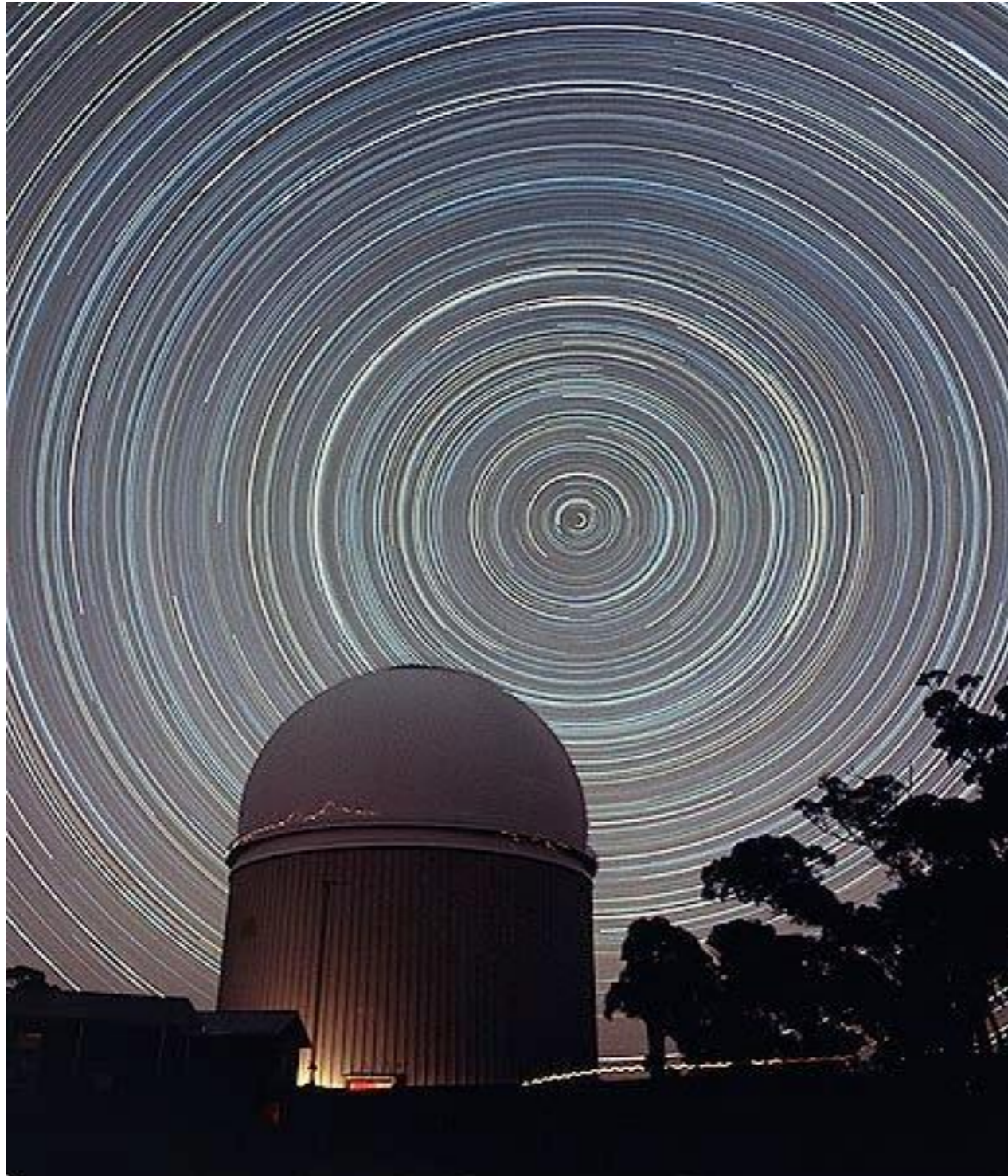
Arguments Against:

- ❑ The Sun moves
- ❑ If you jumped up you would not land in the same spot
- ❑ If the Earth was spinning at that rate, the speed at the equator is over a 1000 mph and you should be flung off.

What is the evidence for?



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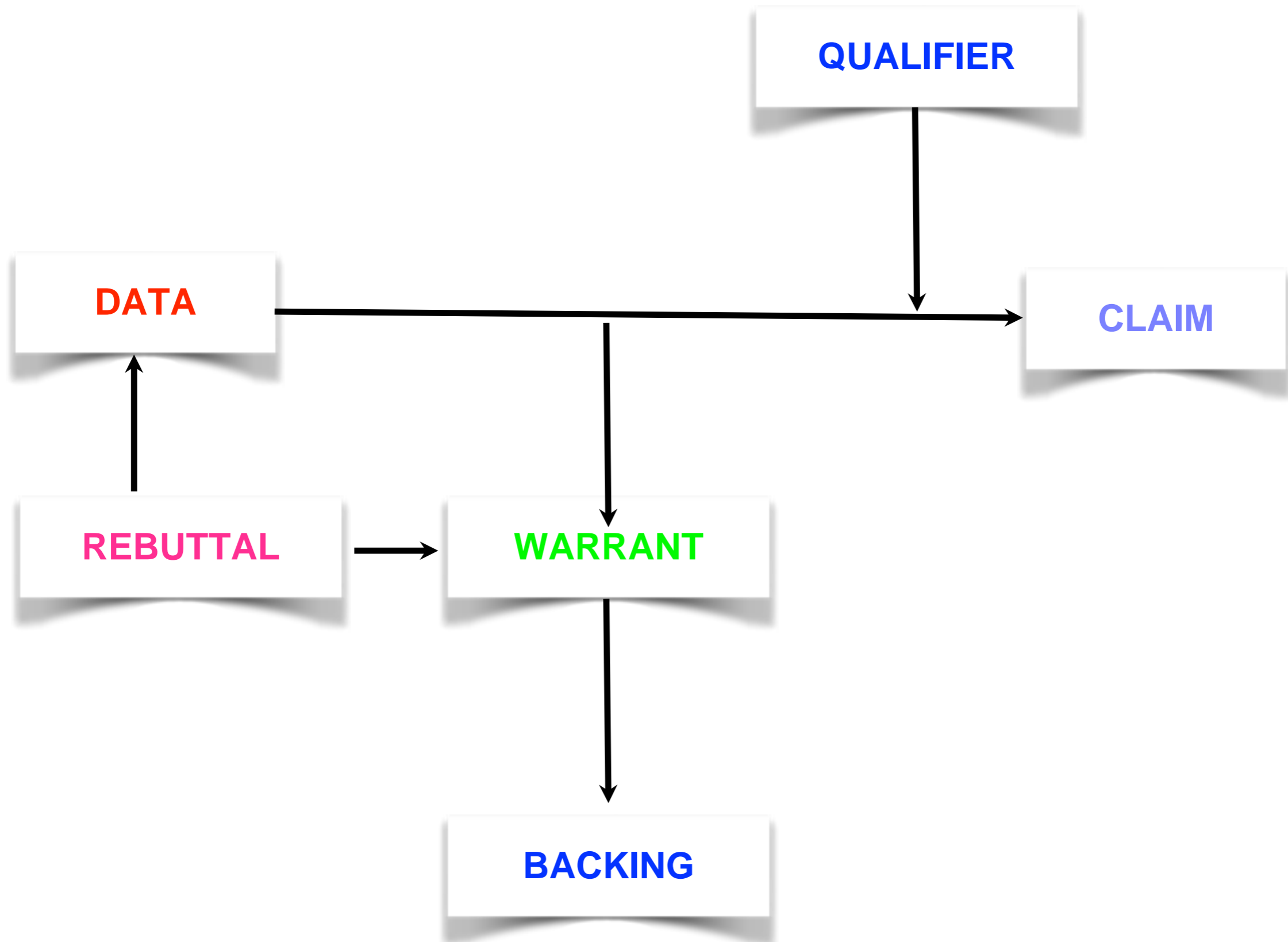


A Structure for Deoxyribose Nucleic Acid

WE wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest.

A structure for nucleic acid has already been proposed by Pauling and Corey¹. They kindly made their manuscript available to us in advance of publication. Their model consists of three intertwined chains, with the phosphates near the fibre axis, and the bases on the outside. In our opinion, this structure is unsatisfactory for two reasons: (1) We believe that the material which gives the X-ray diagrams is the salt, not the free acid. Without the acidic hydrogen atoms it is not clear what forces would hold the structure together, especially as the negatively charged phosphates near the axis will repel each other. (2) Some of the van der Waals distances appear to be too small.

Another three-chain structure has also been suggested by Frazer (in the press). In his model the phosphates are on the outside and the bases on the inside, linked together by hydrogen bonds. This structure as described is rather ill-defined, and for this reason we shall not comment on it.



Data

Claim

Humans burn fossil fuels releasing CO₂
Carbon Dioxide levels are increasing
Mean temperatures are rising

Global Warming, caused by humans, is definitely happening

Temperatures on the Earth vary naturally

Carbon dioxide captures solar radiation and reradiates it at wavelengths which cannot escape from the Earth

Rebuttal

Warrant

Backing

A similar effect occurs in greenhouses

Examples of Argument

Handout 3.1

Stanford is a better football team than Berkeley. It has won more football matches at home and away because its players have superior skills.

It is wrong to plant genetically modified crops. The pollen from the crops will escape. This will cause their genes to spread throughout all similar species with totally unknown outcomes.

We see objects because light enters the eye; as we cannot see in the dark vision must be caused by light entering the eye rather than rays leaving the eye.

Covering a leaf with aluminium foil will cause it to go yellow. A starch test on the leaf shows that no starch has been produced in the leaf compared to other leaves. Light must be responsible for producing the starch unless it is some effect of the aluminium.

The Moon must shine by reflected sunlight. We cannot see the Moon during the day so it cannot be very bright. Otherwise we would be able to see it like the Sun.

What is the Evidence?

Handout 1.1

For each of the following beliefs that we commonly teach in science,

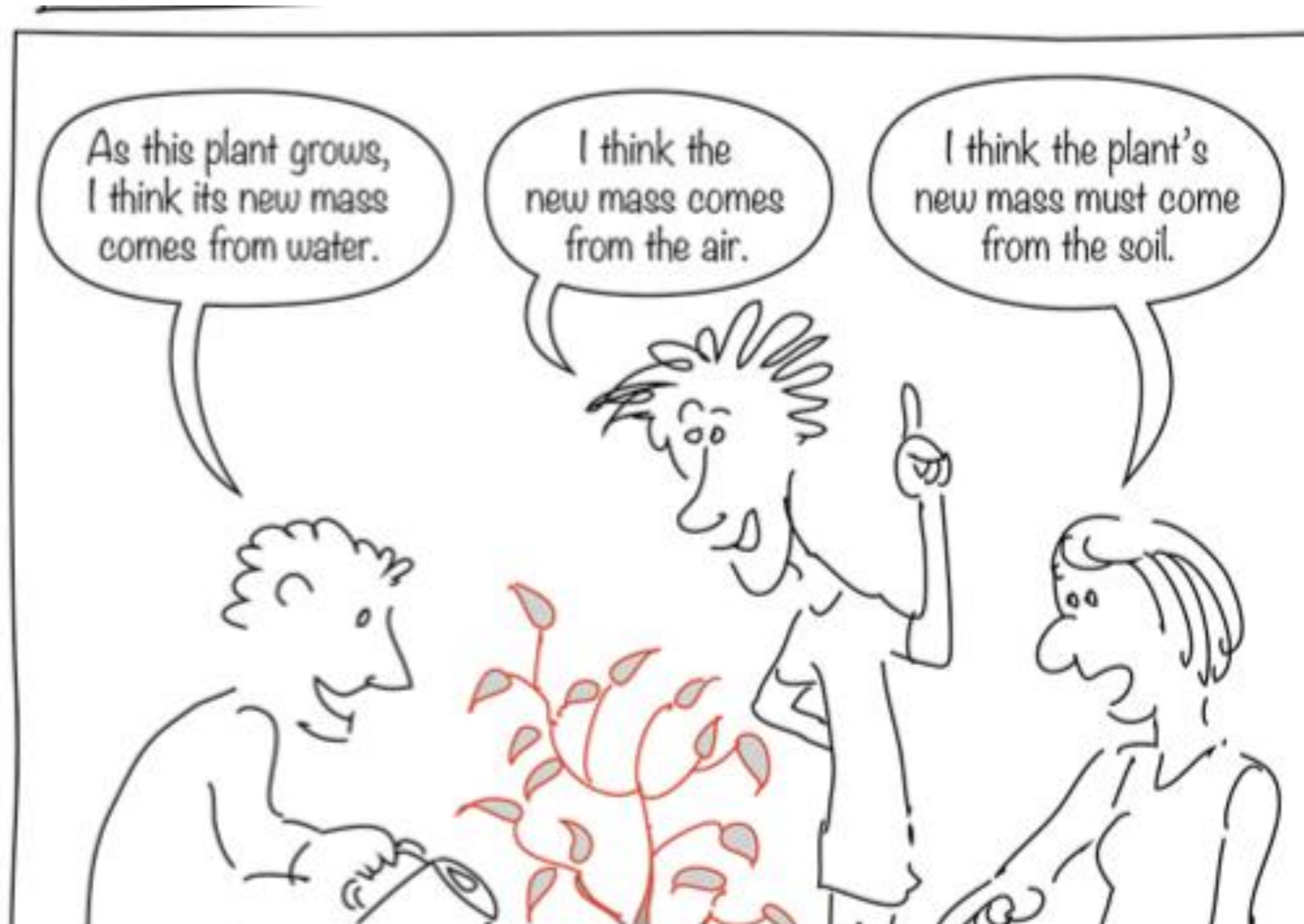
- Provide any evidence to support the belief
- Provide an argument which shows how the data is related to a claim.

Idea	Evidence
Forces are pushes and pulls	
Plants take in carbon dioxide and give out oxygen during photosynthesis	
Day and night are caused by a spinning Earth	
Current is conserved in a simple circuit	
Matter is conserved in a chemical reaction	
Living matter is made of cells	
Lithium, sodium, and potassium are similar elements	
We live at the bottom of a 'sea of air'	
Seasons are caused by the tilt of the earth's axis	

What is the Evidence Against?

- Gases do not weigh anything
- Heavier things always fall faster
- We see because light rays come out of the eye

Engaging Students in Argumentation





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Argument Line



Different
Countries see
different
Phases of the
Moon on the
same day

Different
Countries see the
same Phases of
the Moon on the
same day

Four Corners

Strongly
Agree

Agree

**Wolves should be
a protected
species in Finland**

Disagree

Strongly
Disagree

Establishing the Norms

1. Valuing Student Talk
2. Set Norms and Expectations
3. Clarify Expectations
4. Reinforce Expectations
5. Include All students
6. How long does it take?

Resources

- Science: April 23, 2010
<http://www.sciencemag.org/content/328/5977/463.abstract>
- Tools For Teaching Science:
www.tools4teachingscience.org
- Productive Talk Moves
inquiryproject.terc.edu
especially PD for teachers ->
Library of Resources

