

# PhyzGuide: The Why-How Tree

**Learning to think like a four year-old. With thanks to Walt Scheider.**

When you were four years old, the world was a strange and wonderful place. Everything seemed so new and mysterious. And at four, you had a vocabulary large enough to begin asking questions (just ask Mom or Dad). You asked questions about everything and were never satisfied by the answers.

“Mommy, why do cats meow?” “Because that’s their way of talking.”

“Why don’t they sound like us?” “Well, because their mouths are different from ours.”

“Why?” “Well, that’s just the way it is.”

“But why?”...

Chances are that you drove many adults up the wall with all these questions. To you, these were important questions; you really wanted to know why cats meow, or why it rains, or why your eyes are blue. To many grown-ups, these were questions they didn’t have the time or patience to answer, or didn’t know how to answer.

From that time on, you have probably been discouraged from asking so many questions. And that’s unfortunate. Discouraging such questions dulls one’s curiosity.

In physics, you will do better to think like a four-year old. Why? Because all those questions you asked as a youngster have their ultimate answer in physics. Even the cat’s meow is ultimately explained in terms of the Rules of the Universe.

To see how everything we see is related ultimately to physics, let’s examine the question of why one’s eyes might be blue.

**WHY/HOW did you come to have blue eyes?**

*You inherited them.*

**WHY/HOW?**

*Through your genes.*

**WHY/HOW?**

*The DNA in your genes carries the blueprint for your whole body.*

**WHY/HOW?**

*The DNA molecule forms base-pair bonds with its four types of building block molecules allowing the DNA to make exact chemical copies of itself.*

**WHY/HOW?**

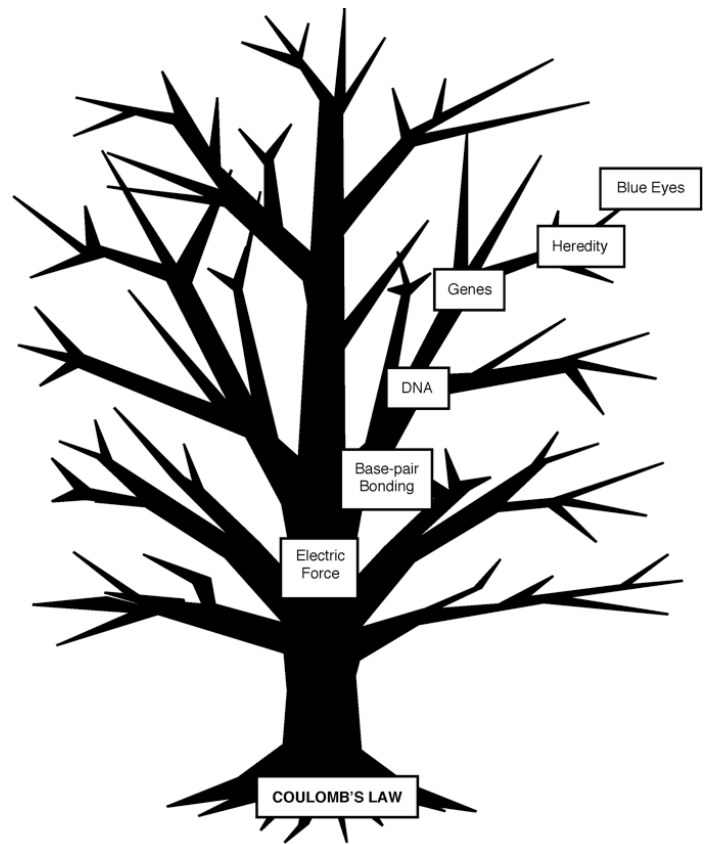
*Electric forces make the base-pair bonds.*

**WHY/HOW?**

*Coulomb’s Law of Electric Forces.*

**WHY/HOW?**

*At this point, we don’t have an answer to that question. We can answer no more “Why’s” or “How’s.”*



We started with a **biological** question and have traced it to a **chemical** explanation which, in turn, we traced to the **physics** of chemical bonds.

# PhyzGuide: The Structure of Science

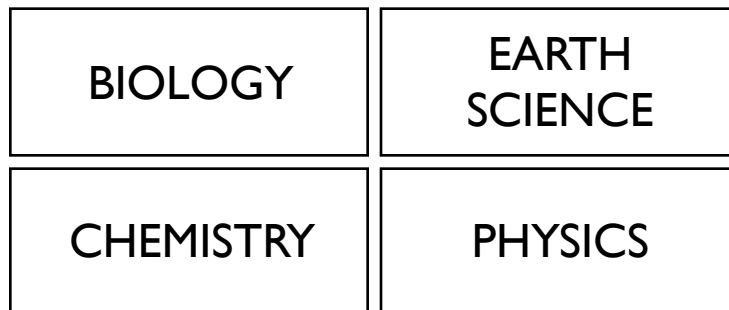
## Food Groups or Venn Diagrams?

If you're like most physics students, you've "seen it all" as far as science goes. You've been through chemistry, biology, and perhaps earth science, and now you're out to tackle physics. But before you jump into the study of physics, you need to understand how physics fits into the general scheme of science.

It often seems that the sciences are unrelated: In biology, you studied plants and animals; in chemistry, you studied the periodic table and chemical reactions; and you expect that in physics, you will study motion and energy. It seems that the sciences are divided into separate groups -- somewhat like the well-known division of food groups.

### THE "FOUR FOOD GROUPS" OF SCIENCE

Is each science independent of the others?



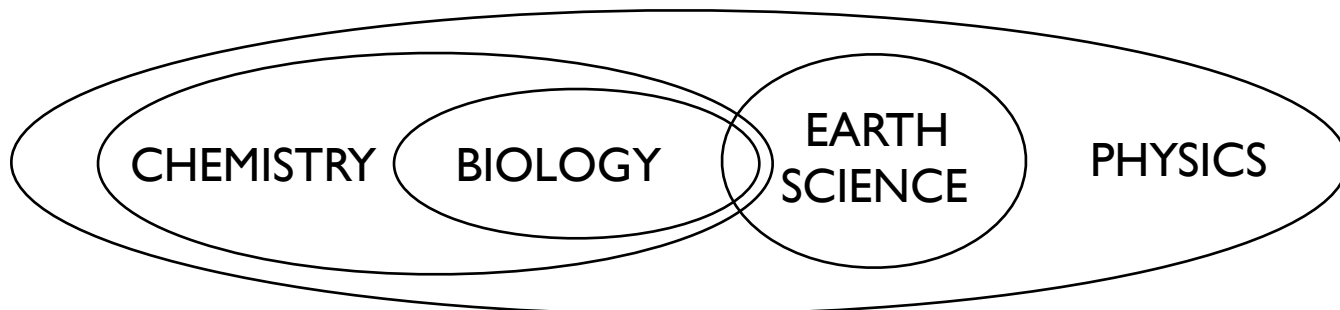
But the sciences are not separate groups as shown above. The sciences are related to each other very directly. **Biological** processes are actually complex **chemical** reactions. Cell division, osmosis, and other such processes can be explained by the principles of chemistry. (The exact details of many biological processes are not yet fully explained in terms of chemistry, but we know that biology can ultimately be understood through chemistry.) **Chemical** reactions are electron interactions. The behavior of those electrons is determined by the principles of energy and electrical force. The principles of energy and electrical force are the domain of **physics**. Phenomena studied in **earth science** can be explained primarily in terms of **physics**.

*Physics is the "bottom line" of science.*

Any science you've studied (and any science you will ever study) is related to physics in some way. The figure below shows how the sciences are really related. These relations are shown as a Venn diagram.

### THE VENN DIAGRAM OF SCIENCE

All sciences are subsets of physics.



This is a simplified picture of the relations between the sciences, but it is useful in providing an orientation toward science. Many other fields of science exist, and yet they don't appear on our diagram. As it turns out, those other sciences are divisions or combinations of biology, earth science, chemistry, and physics. For instance, botany and zoology are divisions of biology, etc. and biophysics combines the study of biology with the study of physics.

Your next question might be, "Well, if all the other sciences are subsets of physics, then what is physics a subset of?" To which I would respond, "Never end a sentence in a preposition." Actually, that's a very good question. The answer is that there is nothing more basic than physics. The only science more fundamental than physics is more physics. For a clarification of this idea, see "The Why-How Tree." ...*P.S. It's O.K. to end a sentence in a preposition.*