SCIENCE:

GOALS, Definition & Character or Process
The GOAL of SCIENTISTS:

The end-goal of EVERY scientist is to:

– use the Scientific Method to discover the Scientific Laws of the Universe AND...
– To prove to the public that they have discovered TRUTH by an accurate prediction
SCIENCE is the ORGANIZED SYSTEMATIC STUDY of the NATURAL LAWS of the UNIVERSE.
DEFINE EACH OF THE IMPORTANT (UNDERLINED) TERMS OF THIS DEFINITION...
SCIENCE Terms:

ORGANIZED
SYSTEMATIC
STUDY
NATURAL
LAWS
UNIVERSE
ORGANIZED = the RULES or the LIMITS of Science...

- The minimum qualifications, limits, rules, or assumptions one must accept to use SCIENCE or to be member of the Scientific Establishment...
ORGANIZED: ORGANIZATIONS all have minimal RULES, assumptions or qualifications that must be met to consider oneself a member of that group...
ORGANIZED:

Rules/Limits/Assumptions

All SCIENTISTS agree to use the same PROCEDURE to gain knowledge about the Universe…

AND…
Limits to science (Organized):

Scientists may only research things that are:

- **DETECTABLE** by the humans senses
- **MEASURABLE** in a **RELIABLE REPEATABLE** way using the **METRIC SYSTEM**
- Able to be assigned a **NUMBER** that means the same thing to everyone
- **MORAL & RESPONSIBLE**…
Systematic is the term that represents the system, method, or procedure accepted by scientists as the ONLY way by which they may gain knowledge about the Universe – THE SCIENTIFIC METHOD.

The Scientific Method is about 1600+ yrs old & consists of the following steps which are NOT applied regimentally but as a way of “thinking” in an orderly manner…
Systematic:

The Scientific Method:

- Observation of the Universe
- Hypothesis statement
- Null Hypothesis statement
- Designing the experiment properly
- Performing the experiment
- Collecting Data (Metric)
- Analyzing the Data for Significance
- Repeating the experiment
- Stating a Conclusion
- Publishing the experiment
The Scientific Method

Scientists don’t just “look about” for a problem to investigate! They already have an area of knowledge in which they are interested... they try to discover the **SCIENTIFIC LAWS** of the Universe usually using correlation & looking to prove **CAUSALITY**.
The Scientific Method

HYPOTHESIS

A POSITIVE hypothesis is a statement of what you really believe is happening concerning the problem you are trying to solve...

NOTE: a POSITIVE hypothesis is VERY DIFFICULT TO PROVE!
A NULL HYPOTHESIS is a hypothesis stated in the Negative...

_?_ has NO EFFECT on the variable being investigated.
Proper Experimental Design with mechanisms to:

- AVOID Confounds
- INCREASE Generalizability

Proper Experimental Design involves having a minimum of two experimental groups; the:

- TEST GROUP which receives the variable
- CONTROL GROUP which receives the PLACEBO instead of the variable
CONFOUNDSD are “errors” in the experimental design which provide results that are invalid and not applicable to any defined situation.

There are several standard ways to avoid CONFOUNDSD:

- Restrict yourself to one variable per experiment
- Randomize the subjects
- Make the experiment “Double-blind & PLACEBO controlled”
- Repeat the experiment MANY times
- LIMIT the conditions of the experiment
GENERALIZABILITY should be increased to maximum in any experiment. Generalizability is the degree of reality you are attempting to create in your experiment… Does your experimental results represent what “really happens” in life or is it an artifact or artificially created condition?

There are several ways to increase Generalizability & each COSTS MORE $:

- Increase the size of your experimental groups
- Increase the sites or places where you perform the experiment
- Do the experiment at different time
- Use a Statistical Sample of the population

NOTE: you must balance…
PERFORM THE EXPERIMENT

Do the experiment several times and EXACTLY as designed…
COLLECT the DATA

Always collect the numerical data from the experiment using METRIC measurements.
The Scientific Method

**ANALYZE the DATA for SIGNIFICANCE**

Analyze the data you collect from the experiment using STATISTICS. Test the RESULTS for Significance!
The Scientific Method

REPEAT REPEAT REPEAT REPEAT…

Always do the experiment MANY times… if you get the same or similar results EACH time… then,
The Scientific Method

STATE A CONCLUSION

✓ Using what you learned from analyzing the results, state a **LIMITED CONCLUSION**...

✓ Remember that you must **ACCEPT** or **REJECT** your NULL HYPOTHESIS

✓ NEVER try to make even a “COMMENT” using results that were **NOT SIGNIFICANT**, such experiments are NULL & VOID and you learned **NOTHING** from them!
If you don’t publish, how will anyone know what you have discovered? AND… remember that you must “know” the editors and “movers and shakers” in your field as they decide WHO gets published!
A “study” is the search for COMPLETE KNOWLEDGE concerning a topic… it is also the search for the SCIENTIFIC LAWS…
“Natural” applies to **NATURE** and nature is defined as those things in the Universe that are **DETECTABLE** with the Human Senses or by the use of a machine that reports values recognizable to the Human Senses.
A “law” in this usage is NOT a LEGAL LAW but a SCIENTIFIC LAW. A Scientific Law is one that “has always been TRUE, is TRUE NOW, and always WILL BE TRUE.”

Scientific Laws arise from years of experimentation and acceptance and over thousands of years…

a Scientific Law progresses in a circuitous manner from an experi-mentally proven Hypothesis to an accepted Theory to a unassailable immutable Scientific Law… (The Character or Nature of the Scientific Process)
The **UNIVERSE** is defined as **EVERYTHING THAT “IS.”**
The Character or Nature of the Scientific Process:

The PROCESS OF SCIENCE involves the numerous steps (& back-steps) involved in discovering the immutable unchangeable SCIENTIFIC LAWS that govern the Universe.

The steps involved in moving from a HYPOTHESIS to a THEORY to a SCIENTIFIC LAW are numerous “backwards circles!” This is NOT a linear progression…

The discovery of a SCIENTIFIC LAW usually takes thousands of years of Scientific Experimentation and FAILURE…