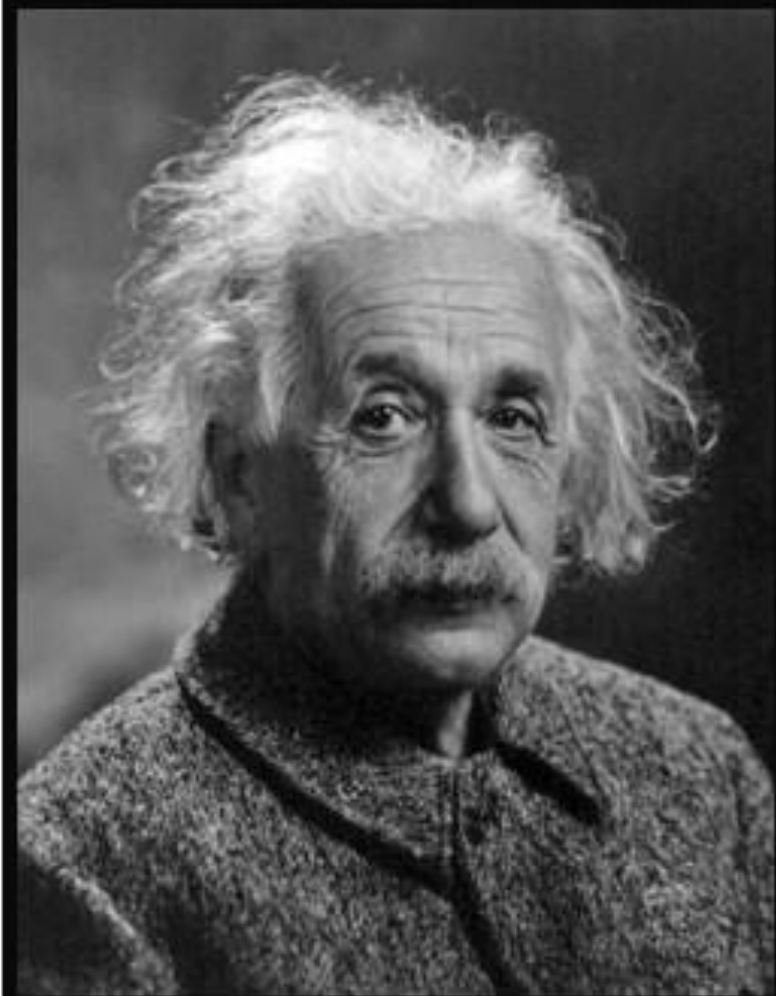


Lecture 1: Methodology: What is Scientific Research Method?

What is research?

- Research is a process to look for or search for an answer for a specific question in a specific field (Science: Biology, Chemistry, and Physics or interdisciplinary science).
- The results of research usually lead to new findings which eventually would enhance our understanding in a specific topic.
- Characteristics of research;
- It demands a clear statement of the problem,
- It requires a plan (it is not aimlessly “looking” for something in the hope that you will come across a solution),
- It builds on existing data, using both positive and negative findings,
- New data should be collected as required and be organized in such a way that they answer the research question(s).





If we knew what it was we were doing, it would not be called research, would it?

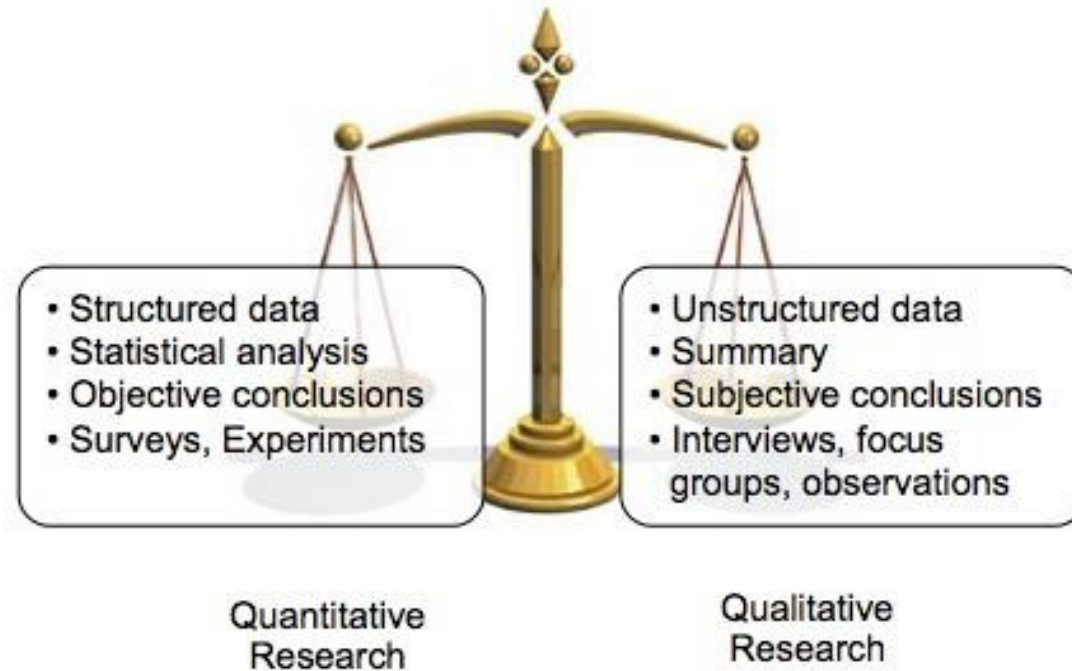
(Albert Einstein)

Types of research

- Research is a systematic approach for information and new knowledge.
- It covers topics in every field of science and perceptions of its scope and activities are unlimited.
- The classical broad divisions of research are: **basic and applied research**.
- **Basic research:** refers to study and research that is meant to increase our scientific knowledge base. This type of research is often purely theoretical with the intent of increasing our understanding of certain phenomena or behavior but does not seek to solve or treat these problems.
- For example:
- an experiment to determine a simple fact.
 - What are protons, neutrons, and electrons composed of?
 - What is the specific genetic code of the fruit fly?
 - How do bacteria reproduce?

- **Applied research:** Applied research focuses on analyzing and solving real-life problems. This type refers to the study that helps solve practical problems using scientific methods. Studies play an important role in solving issues that impact the overall well-being of humans. For example: finding a specific cure for a disease.
- Treat or cure a specific disease,
- Improve the energy efficiency of homes, offices, or modes of transportation.
- Ways to market products,
- How to reverse or manage global warming,
- Is genetically modified food hurting health?



Quantitative and Qualitative Research



- **Qualitative research** is concerned with developing explanations of social phenomena.
- The field of social sciences: psychology, sociology, anthropology etc.
- They were interested in studying human behaviour and the social world inhabited by human beings.
- That is to say, it aims to help us to understand the world in which we live and why things are the way they are.
- It is concerned with the social aspects of our world and seeks to answer questions about:
 - Why people behave the way they do
 - How opinions and attitudes are formed
 - How people are affected by the events that go on around them
 - How and why cultures have developed in the way they have

- **Quantitative research**, on the other hand, is more concerned with questions about: how much? How many? How often? To what extent? etc.
- It is numerical, non-descriptive, applies statistics or mathematics and uses numbers.
- It is an interactive process whereby evidence is evaluated.
- The results are often presented in tables and graphs.
- It is conclusive.
- It investigates the what, where and when of decision making.
- **Briefly:** Qualitative research methods **focus on words and meanings**, while quantitative research methods **focus on numbers and statistics**.

Examine the differences between qualitative and quantitative data.

Qualitative Data	Quantitative Data
<p>Overview:</p> <ul style="list-style-type: none">• Deals with descriptions.• Data can be observed but not measured.• Colors, textures, smells, tastes, appearance, beauty, etc.• Qualitative → Quality	<p>Overview:</p> <ul style="list-style-type: none">• Deals with numbers.• Data which can be measured.• Length, height, area, volume, weight, speed, time, temperature, humidity, sound levels, cost, members, ages, etc.• Quantitative → Quantity
<p>Example 1:</p> <p><i>Oil Painting</i></p>  <p>Qualitative data:</p> <ul style="list-style-type: none">• blue/green color, gold frame• smells old and musty• texture shows brush strokes of oil paint• peaceful scene of the country• masterful brush strokes	<p>Example 1:</p> <p><i>Oil Painting</i></p>  <p>Quantitative data:</p> <ul style="list-style-type: none">• picture is 10" by 14"• with frame 14" by 18"• weighs 8.5 pounds• surface area of painting is 140 sq. in.• cost \$300

- For example: to test the hypothesis 'listening to music lowers blood pressure levels' there are 2 ways of conducting research:
- **Experimental**- group samples and make one group listen to music and then compare the bp levels,
- **Survey**- ask people how they feel? How often they listen? And then compare.

What is the main aim of research?

- The main objective of research is to find and better understand a topic that is novel or that we have little knowledge about it.



Research Process

- Research Proposal
- Experimental design
- Data Collection, analysis, interpretation, presentation (Biostatistics)
- Writing and publication

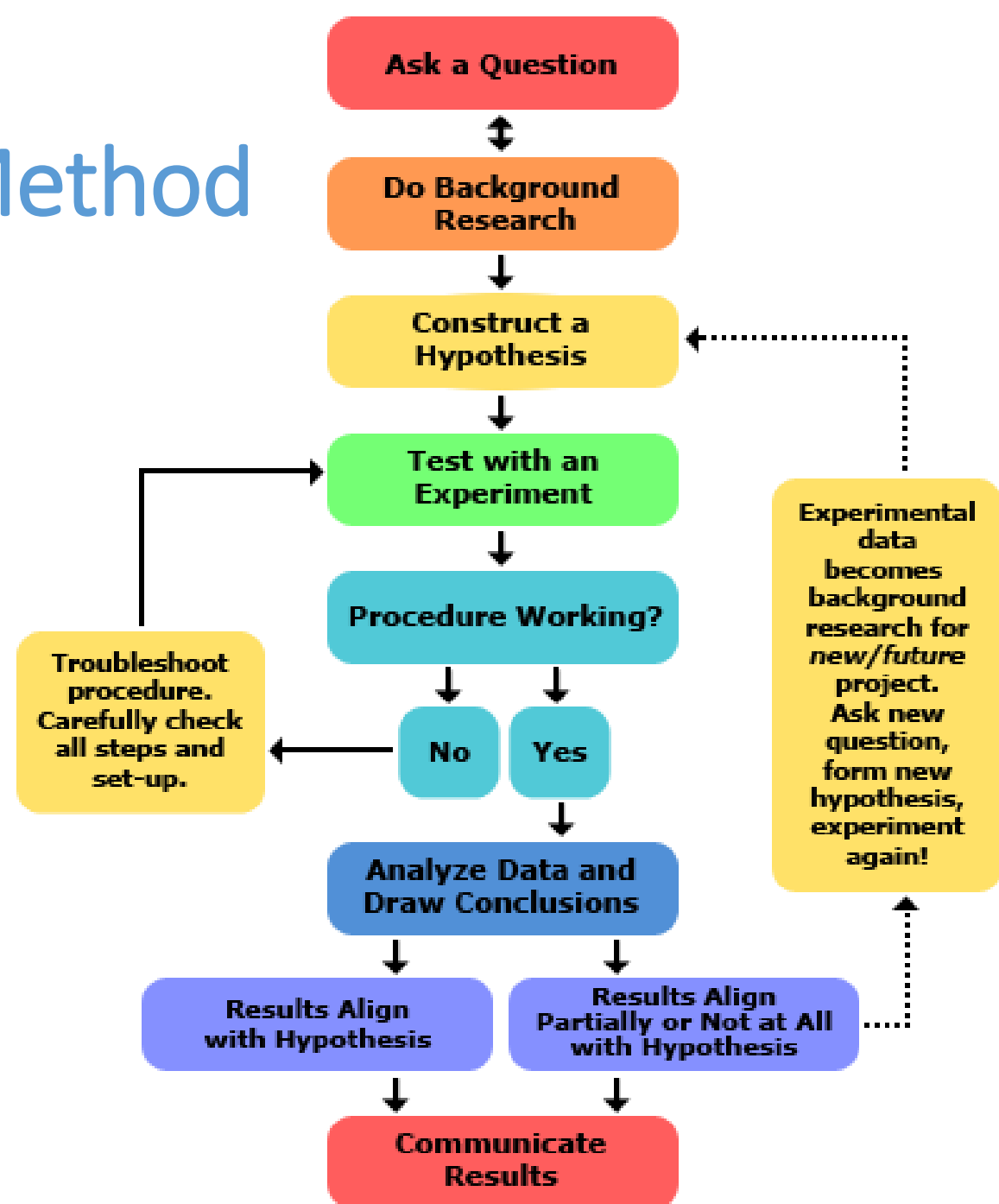
How to conduct research?



You have to be interested in the field you want to do your research in it.

Scientific Research Method

Observation



Amyotrophic lateral Sclerosis (ALS)

- ALS is a lethal and detrimental progressive neurodegenerative disease which affects motor neurons in limbs and respiratory system.
- The life expectancy of inflicted patients is 2-5 years after the patient has been diagnosed with ALS.
- There is no cure for ALS.

Ask a Question

What does cause motor neurons to die in Amyotrophic lateral Sclerosis (ALS) Patients?

Do Background Research


Literature Review in ALS topic Mutations in these genes that cause ALS

- Superoxide dismutase (SOD1)
- Alsin (ALS2)
- VAMP-associated protein B (VAPB)
- TAR DNA binding protein (TDP-43)
- Fused in sarcoma (FUS)
- Mutation in C9ORF72/ GGGGCC hexanucleotide repeat expansion



Construct a Hypothesis

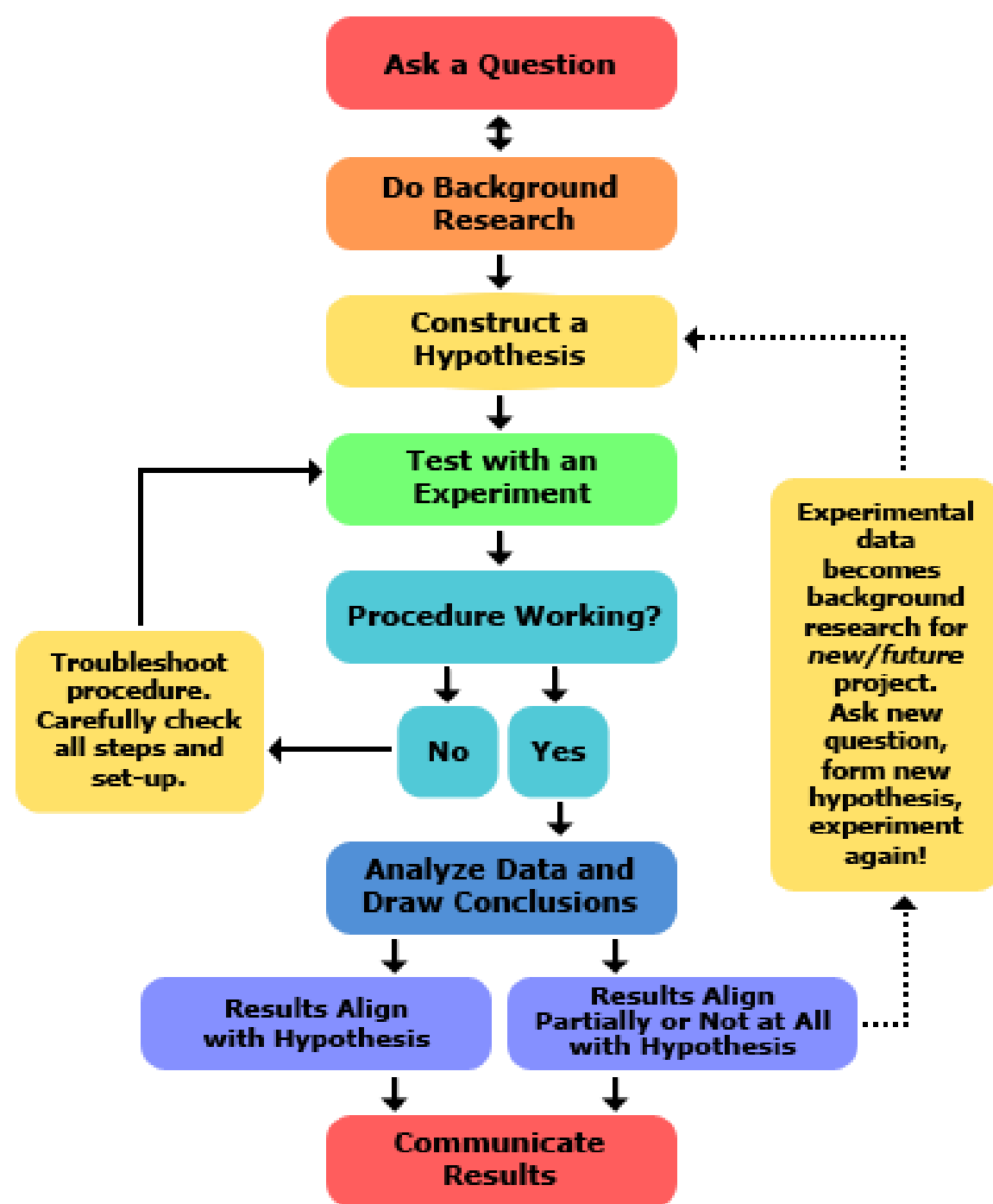
- Mutation in SOD1 might cause motor neuron damage due to the oxidative stress.



Test with an Experiment

Perform experiment *in vitro* or *in vivo* in ALS-related mutant genes in model systems

- Cell culture.
- Model organism, for instance, mouse.



General Terminology in Research

- **Hypothesis:** an idea that has not been proved yet but that results in further study.
- **Experiment:** a scientific test in which you perform a series of actions and carefully observe their effects to learn about something. (used to test the validity of hypothesis)
- **Treatment:** is a process of changing something.

General Terminology in Research

- **Factor:** experimental variables, controllable conditions (light, temperature).
- **Experimental error:** variability due to the techniques or handling.
- **Replication:** repeating an experiment or procedure more than once. (repetition)
- **Randomization:** arrangement of treatments to experiments in a random way.

General Terminology in Research

- **Sample:** number of repetitions that represents the population.
- **Sample size:** total number of samples used in an experiment.
- **Reproducibility:** to cause something to happen again in the same way.
- **Ethics:** rules that determine acceptable and unacceptable things in research.
- **Plagiarism:** to claim other people's work to be your own.

Experimental or Research Design

- Topic, idea
- Sample, model organism, in vivo, in vitro, in silico
- Sample size
- Treatment period, chronic, acute
- Assays, tests
- Statistical analysis, One-way or Two-way ANOVA.

Types of articles

- Original Research
- Review Article
- Short Communication
- Clinical Case Study
- Clinical Trial
- Commentary
- Book review

Original Article outline

- Title, authors
- Abstract
- Introduction, aims of the study (objectives)
- Materials and Methods
- Statistical analysis
- Results
- Discussion
- Concluding Remarks, Future directions
- Acknowledgements
- References

Statistical analysis strategy

1. Collect data
2. Analyze data
3. Interpret your data
4. Present your data in a graph