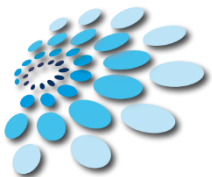


“ Techniques in Cellular
and Molecular
Neurobiology ”

International Master's Degree in Neuroscience

Lesson 1



DIPARTIMENTO DI
SCIENZE DELLA VITA

Gabriele Baj
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Course Description

The course aims to provide a synthetic overview of the major principles and techniques associated with cellular and molecular neurobiology.

The subject matter includes the different approaches that can be used to address biological questions in cellular and molecular Neurobiology

TOPICS – in progress

Provisional

- 1) Presentation and Scientific Method
- 2) The biological problem
- 3) Scientific Model in Neurobiology
 - Descriptive Neurobiology and/or mechanisms research
- 4) Experimental manipulations
 - Genetic
 - Pharmacological

Provisional

5) Experimental “target”

- Structure
- DNA / RNA
- Proteins
- Mechanism and interactions

6) Experimental results and “readout”

- Morphological vs Biochemical



7) Virtual / Real Laboratory

- Video
- Hands ON
- Laboratory tour

8) Scientific research revision

provisional



Course handouts and learning materials on moodle

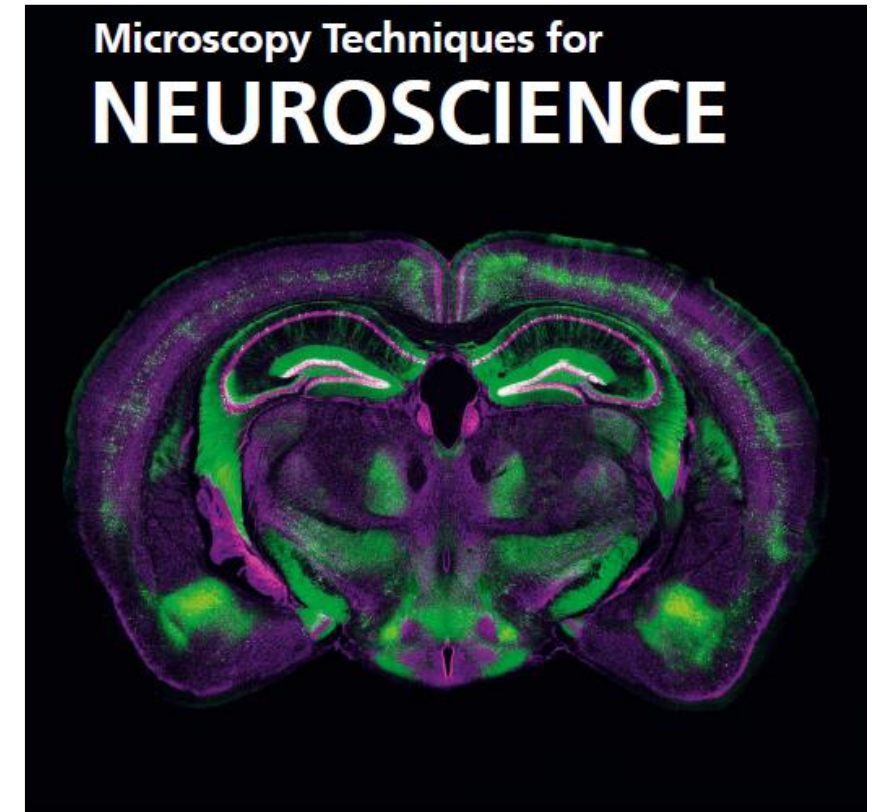
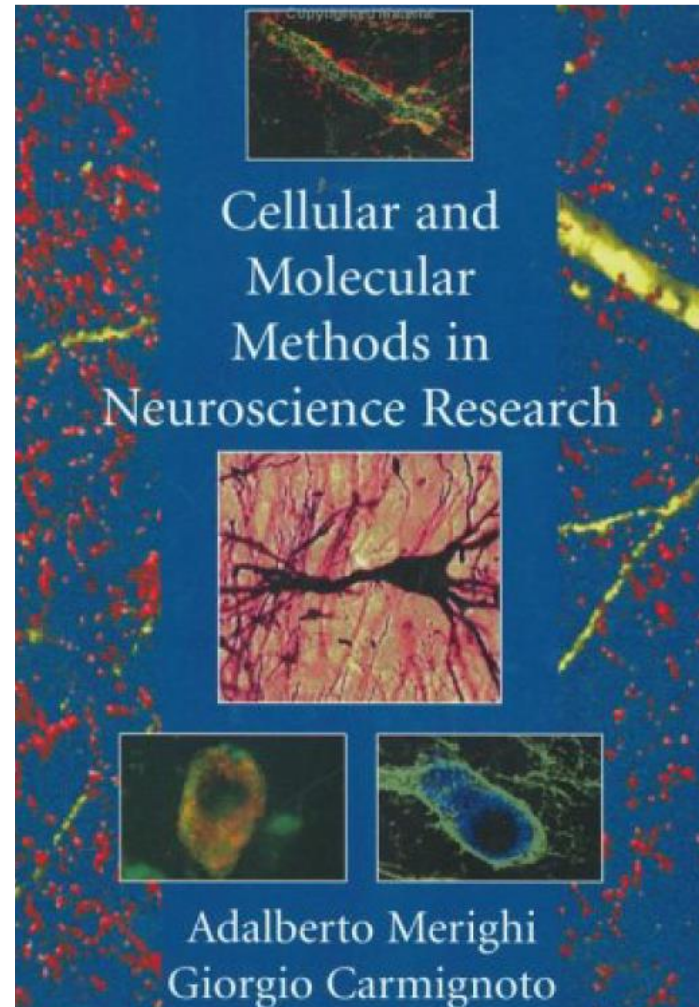
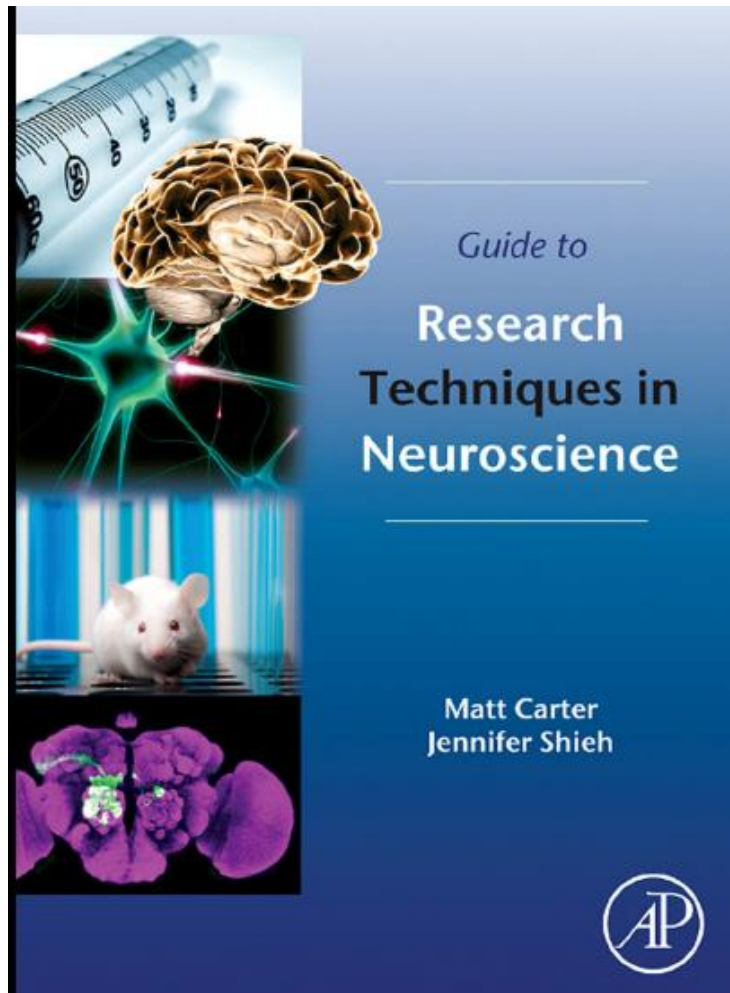
- 1) Lesson handouts
- 2) Video of the lessons (link)
- 3) Video of laboratory activities (link)
- 4) Ebook chapters / Research papers

Technics in Cellular and Molecular Neurobiology



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Selected chapters from



Seeing beyond

WILEY

Examination Procedures

Provisional

1st choice = Written Exam + Oral discussion (if requested)

Methods:	Text with 22 questions with open or multiple choice answers
Evaluation	Correct answer = -1.5 point, partial correct answer = + 0.75 point, no answer = 0 point, wrong answer = - 0.5 points
Oral discussion	The student can ask to discuss the written exam and that can produce a variation on the previous note of + or – 4 points

2° choice = Oral discussion

Methods and evaluation 1 question for each main argument up to 6 or 7 questions.

Notes: The «Baj» part of the exam can be performed all together with the main part «Tongiorgi» or in a different exam date. The «Baj» part of the exam produce a mark that will be «weighted» on the final note (1/4 of the total result)

SCIENTIFIC METHOD



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PURPOSE

State the problem.

RESEARCH

Find out about the topic.

HYPOTHESIS

Predict the outcome to the problem.

EXPERIMENT

Develop a procedure to test the hypothesis.

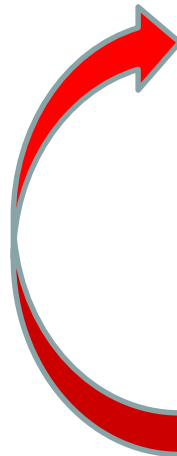
ANALYSIS

Record the results of the experiment.

CONCLUSION

Compare the hypothesis to the experiment's conclusion.

hypothesis
rejected



hypothesis
confirmed



PURPOSE

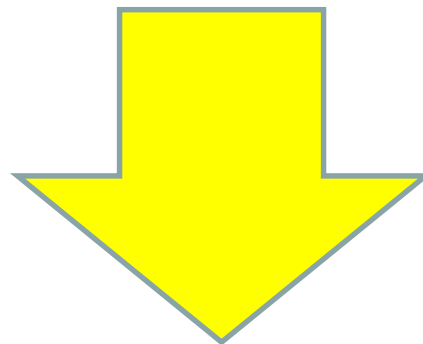
State the problem.



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example

How it works?



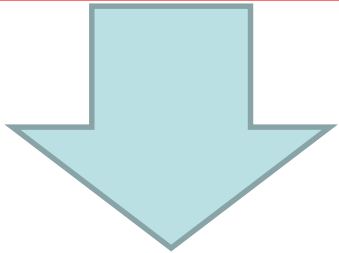
characterization at molecular level

PURPOSE

State the problem.



Pathology cure

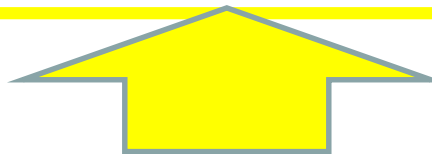


Therapy

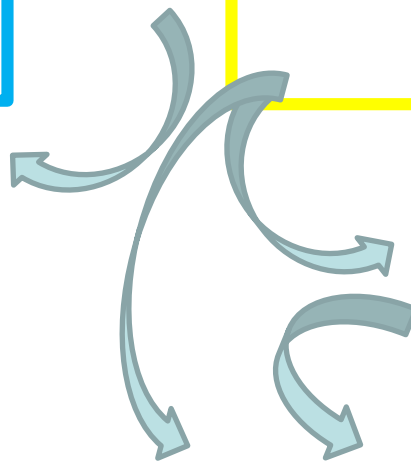
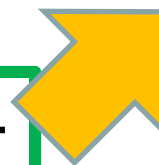


pharmacological target

What's Wrong??
pathology
characterization at
molecular level



target identification

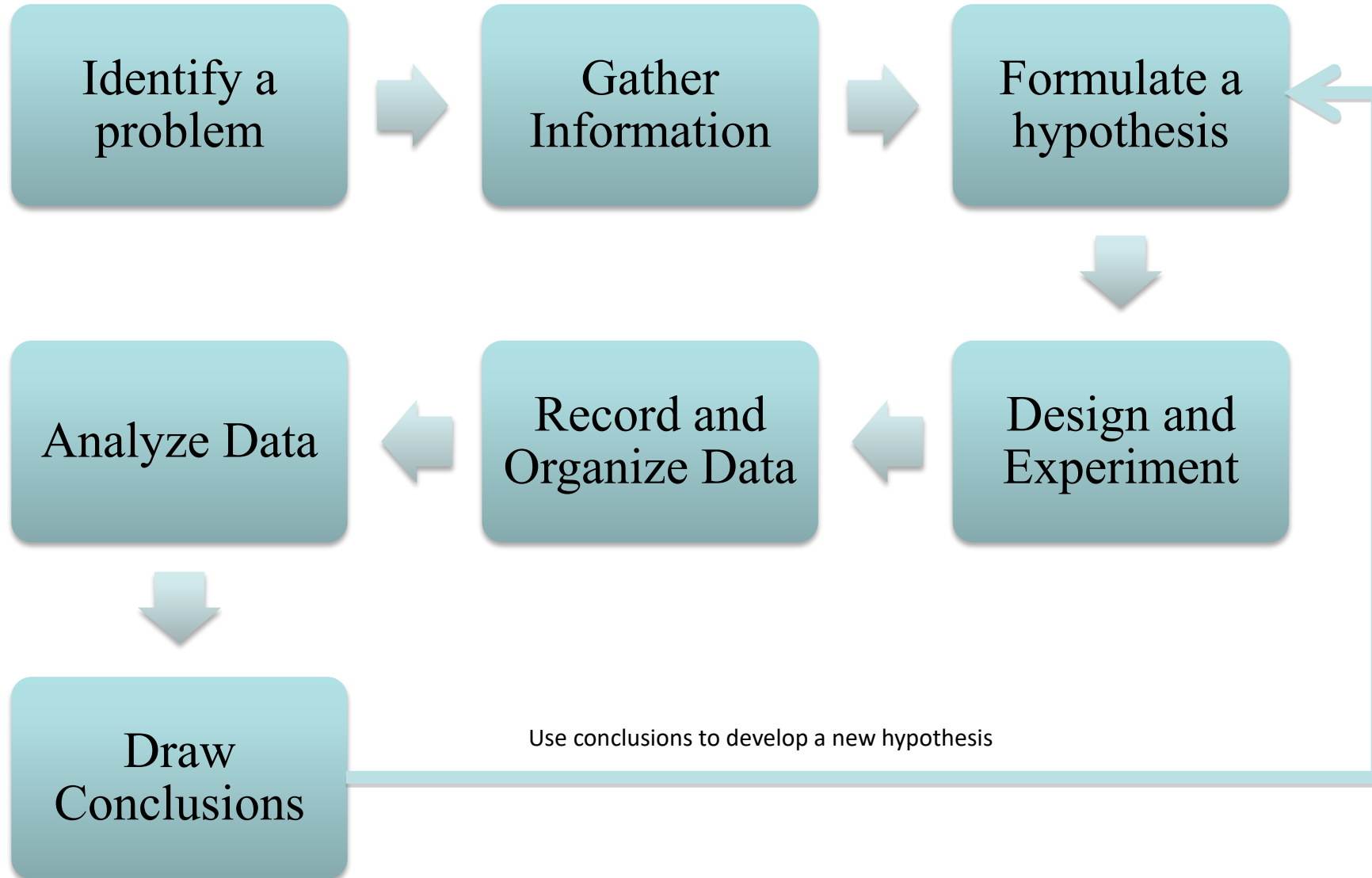


example

Introduction to the Scientific Process



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Problem/Question

Observation/Research

Formulate a Hypothesis

Experiment

Collect and Analyze Results

Conclusion

Communicate the Results

A light blue hourglass-shaped diagram. The top wide part contains the text 'TIME & EFFORTS'. The narrow middle section is a point where the two triangles meet. The bottom wide part is empty.

TIME & EFFORTS

The Scientific Method



- What is the scientific method?
 - It is a **process** that is used to find **answers** to questions about the world around us.

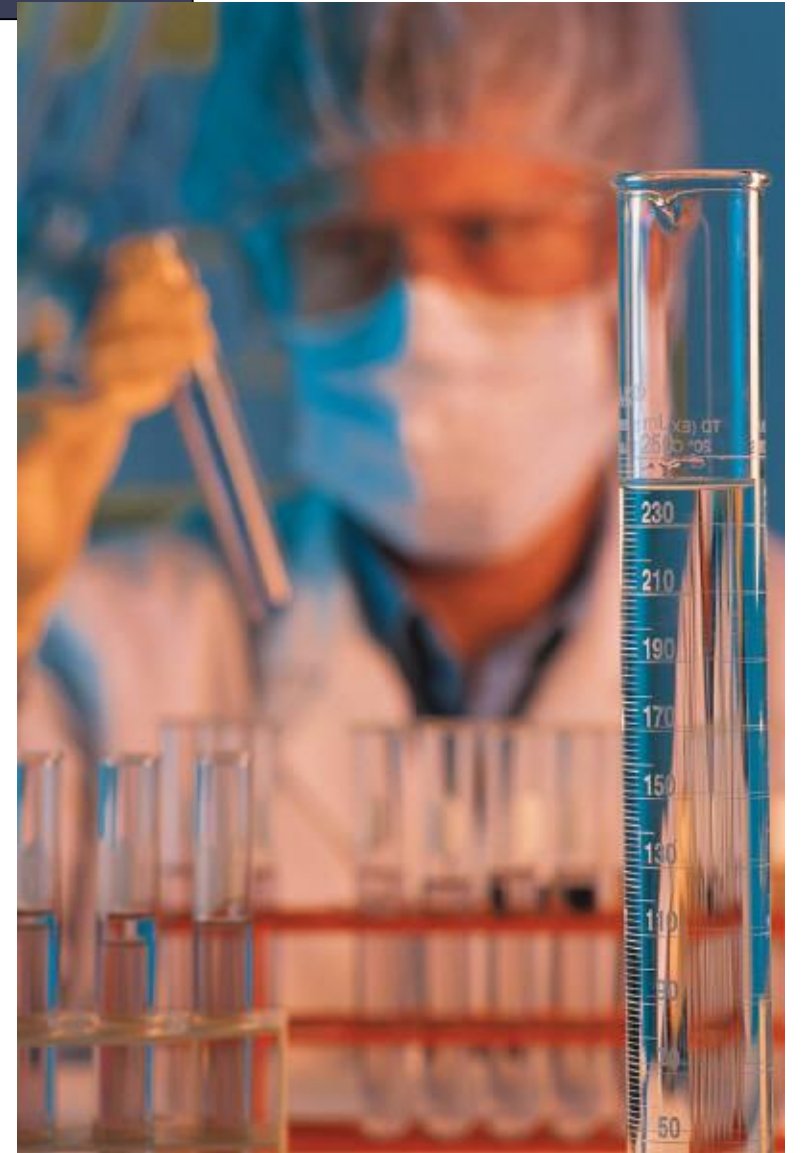


Is there only one “scientific method”?

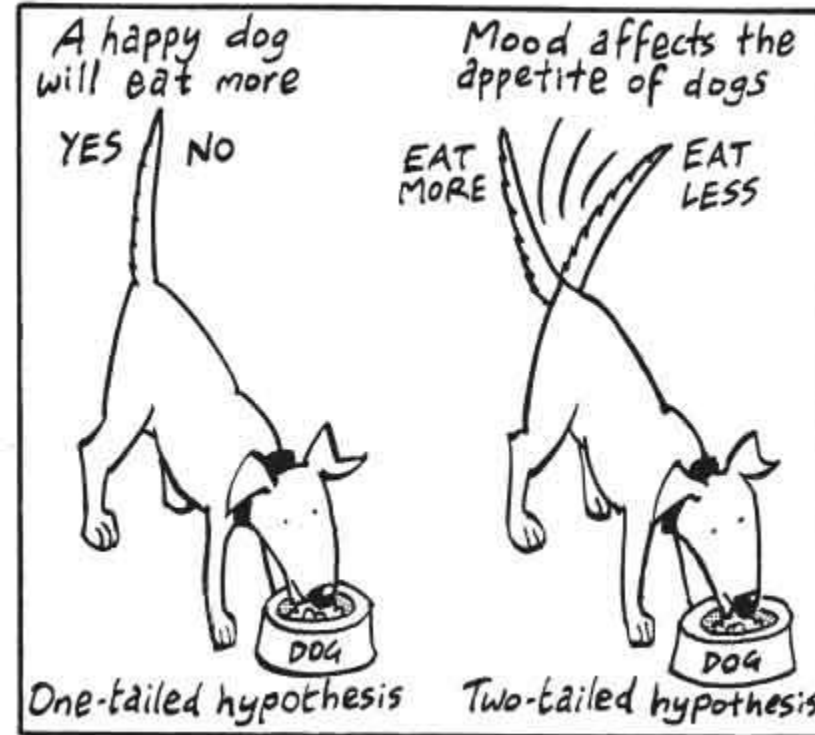


- No, there are several versions of the scientific method.
- Some versions have more **steps**, while others may have only a few.
- However, they all begin with the identification of a **problem** or a **question** to be answered based on **observations** of the world around us.

- They provide an **organized** method for conducting and analyzing an experiment.



- What is a hypothesis?
 - It is an **educated guess** based on observations and your knowledge of the topic.
 - You state it as a possible answer to a question.

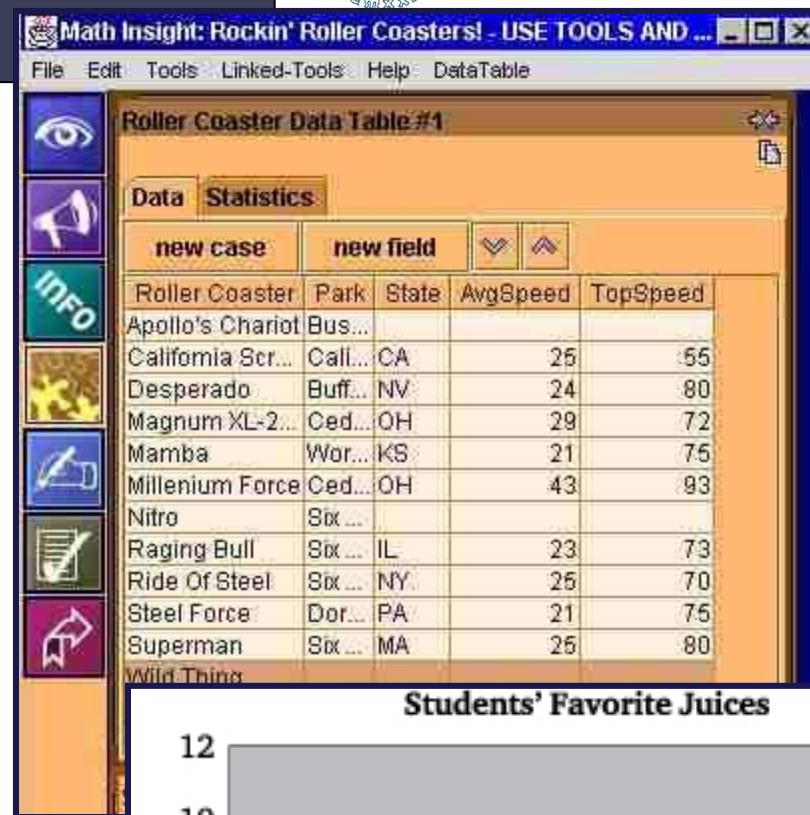


- Stated in the “If....., then....” format
- Example: **IF** I water three plants with different sodas, **THEN** the plant that receives Sprite will grow the tallest.



• What is data?

- It is **information** gathered during an experiment.
- It is organized into a data **table** and displayed visually as a **graph**.



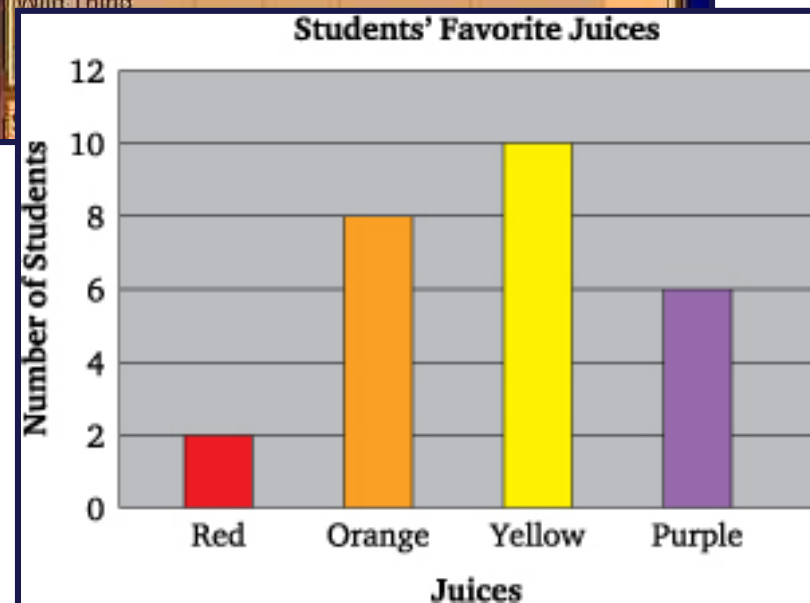
Math Insight: Rockin' Roller Coasters! - USE TOOLS AND ...

File Edit Tools Linked-Tools Help DataTable

Roller Coaster Data Table #1

Data Statistics

new case	new field			
Roller Coaster	Park	State	AvgSpeed	TopSpeed
Apollo's Chariot Bus...				
California Scr...	Call...	CA	25	55
Desperado	Buff...	NV	24	80
Magnum XL-2...	Ced...	OH	29	72
Mamba	Wor...	KS	21	75
Millenium Force	Ced...	OH	43	93
Nitro	Six ...			
Raging Bull	Six ...	IL	23	73
Ride Of Steel	Six ...	NY	25	70
Steel Force	Dor...	PA	21	75
Superman	Six ...	MA	25	80
Wild Thing				



Steps of the Scientific Method



- 1. **Choose a problem:** State the problem as a question.
- 2. **Research your problem:** Read, get advice, and make observations.
- 3. **Develop a hypothesis:** Make a prediction about what will happen.
- 4. **Design an experiment:** Plan how you will test your hypothesis.



- 5. **Test your hypothesis:** Conduct the experiment and record the data.
- 6. **Organize your data:** Create a chart or graph of your data.
- 7. **Draw conclusions:** Analyze your data and summarize your findings.

Identifying Variables



- Independent Variables
- Dependent Variables
- Controlled Variables (Constants)

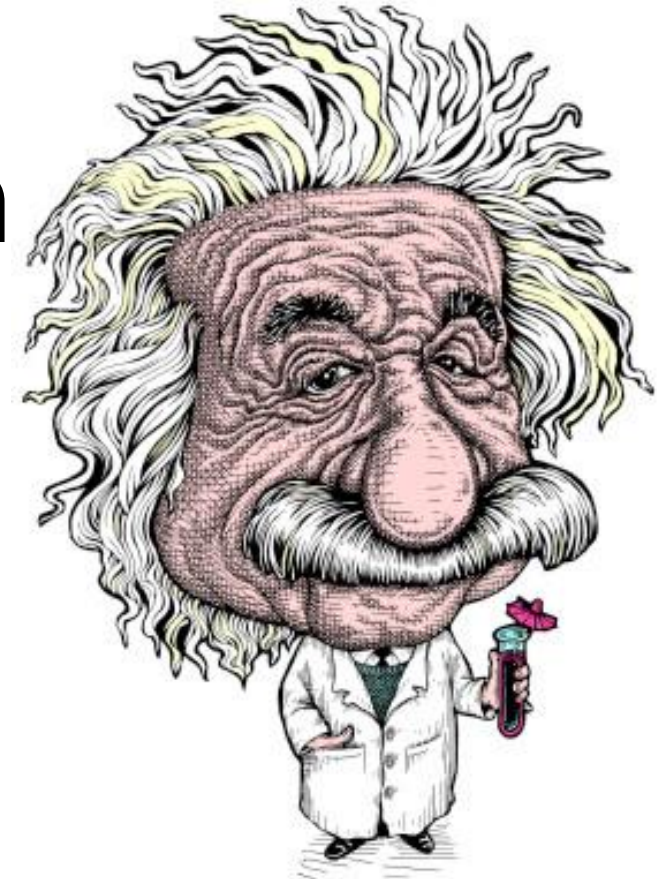


Do you know the difference



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between the independent and
dependent variables?



3 Kinds of Variables



- **Independent Variable** – something that is **changed** by the scientist
 - What is tested
 - What is manipulated (changed)





- **Dependent Variable** – something that might be affected by the change in the independent variable
 - What is observed
 - What is **measured**
 - The **data** collected during the investigation
 - “the **numbers**”
 - Example: how tall the plant grew, how far the paper airplane flew



- **Controlled Variable** – a variable that is not changed
 - Also called **CONSTANTS**
 - Allow for a “**fair** test”
 - Everything in the experiment except for the IV should be kept constant

Procedure



- Give a detailed explanation of how you will conduct the experiment to test your hypothesis
- Be clear about the **variables** (elements you change) versus your **constants** (elements that do not change)
- A **control** is the group that you use as a comparison to see if change has occurred.



Control Group



In a scientific experiment, the control is the group that serves as the standard of comparison.

The control group may be a “no treatment” or an “experimenter selected” group.

Conclusion



- **Conclusion**: your results or findings based on data collected during the experiment
- Answer your **problem**/purpose statement
- What does it all add up to? What is the **value** of your project?
- What further study do you recommend given the results of your experiment? What would be the next **question** to ask?
- If you **repeat** this project, what would you change?

Science experiments use...



- **Independent Variable:** the one factor that is changed by the person doing the experiment
- **Dependent Variable:** the factor which is measured in the experiment
- **Constants:** all the factors that stay the same in an experiment

What experiments are you planning?

- What are your variables?
- How will you keep your experiment fair?

*We will be back here
in final lessons*

Neuroscience and neurobiology



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a field of study that deals with:

- structure, function,
- development, genetics,
- biochemistry, physiology,
- pharmacology,
- pathology of the nervous system,
- study of behavior and learning is also a division of neuroscience

Neurobiology



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- biological study of the brain
- interdisciplinary field that involves many levels of study from the
 - molecular level
 - cellular level (individual neurons)
- small assemblies of neurons like cortical columns
- larger subsystems : subserves visual perception
- large systems : cerebral cortex or cerebellum
- the highest level the nervous system as a whole

Molecular Neuroscience in the 21st Century: A Personal Perspective

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<https://doi.org/10.1016/j.neuron.2017.10.005>

Neuroscience is inherently interdisciplinary in its quest to explain the brain. Like all biological structures, the brain operates at multiple levels, from nano-scale molecules to meter-scale systems. Here, I argue that understanding the nano-scale organization of the brain is not only helpful for insight into its function, but is a requisite for such insight. I propose that one impediment to a better understanding of the brain is that most of its molecular processes are incompletely understood, and suggest a number of key questions that require our attention so that progress can be achieved in neuroscience beyond a description of the activity of neural circuits.



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VIDEO
AUDIO
TEST



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Technics in Cellular and Molecular Neurobiology



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MOLECULAR NEUROBIOLOGY – TECHNIQUES

Electrophysiology

(incl. whole-cell, voltage-clamp, current-clamp, single-channel, perforated patch, loose-patch, cell-attached, field potential recordings);

Tissue preparation and tissue culture (acute slices of olfactory tissue, dissociated neurons, cell lines)

Live cell imaging (incl. confocal and two-photon imaging)

Molecular & Genome Biology (incl. in situ hybridization, single cell/small tissue isolation and gene analysis)

Behavioral assays (resident-intruder assay, Bruce effect,)

Histology (incl. immunohistochemistry, neuroanatomy)

