# برنامج مهارات البحث العلمي (10)

محاضرة «الأخطاء الشائعة في البحث العلمي»

مركز بحوث الدراسات العلمية والطبية

جامعة الملك سعود

# Common mistakes in Scientific Research

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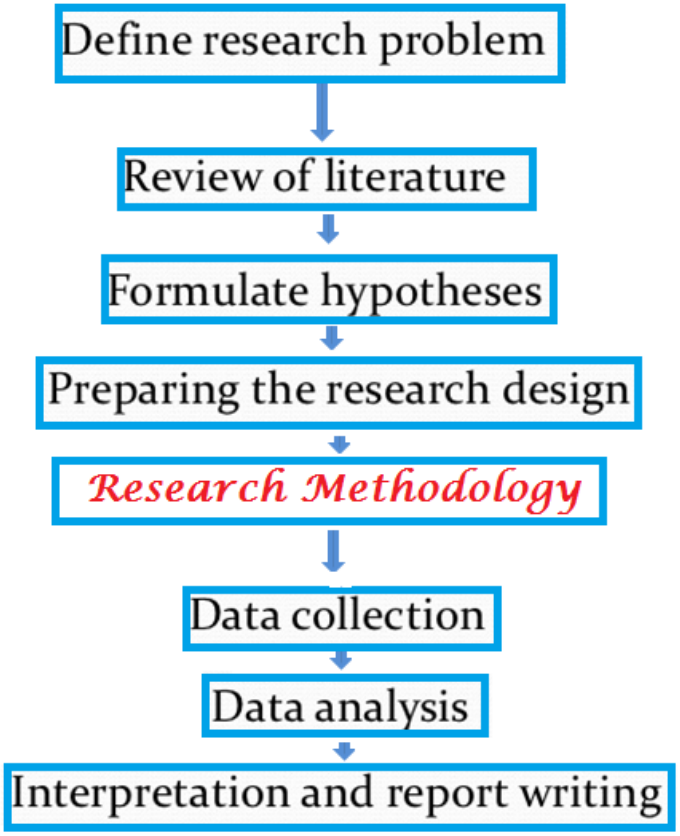
# WHAT IS SCIENTIFIC RESEARCH?

- **Scientific research** is the systematic investigation of **scientific** theories and hypotheses.

# The Research Process




Research methodology

Lots of hard work, failures and frustration, sleepless nights etc

Faultless Research Process

Publication/s

Science is as tough and painful as it (ultimately) is rewarding

# For young researchers.

- A flawless scientific process is easier said than done.
- Why:
  - lack of experience,
  - poor understanding
  - inadequate knowledge
  - Lack of guidance
  - **cruel bad luck**



- A flawless scientific process can only be achieved when we know what is wrong/right in research.
- We must know what are the mistakes we commonly make.

# We all make mistakes

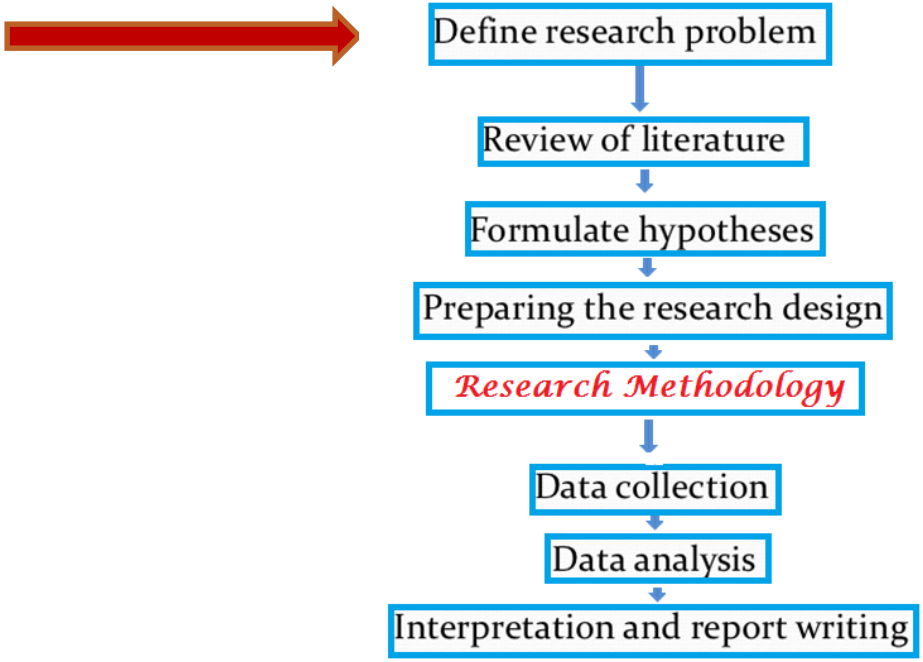
# We must learn from our/others mistakes

*Young researchers should not be too discouraged by mistakes that may occur at first. Instead, they should learn from them.*

*Conduct better research in the future.*

mistake
+
correction
=
learning

# Define Research Problem (topic)

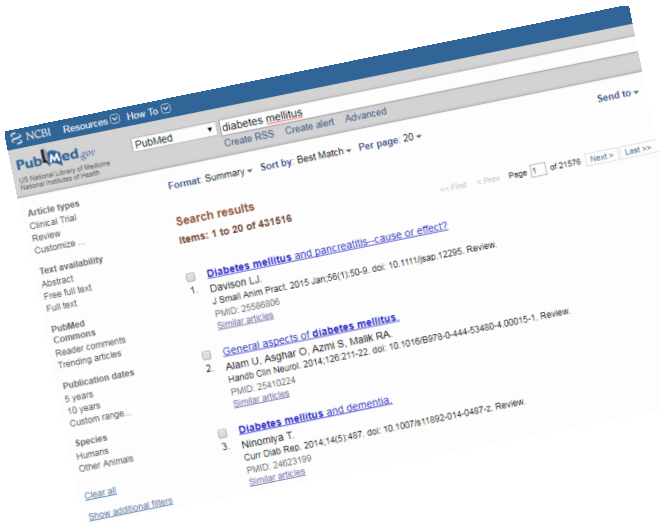



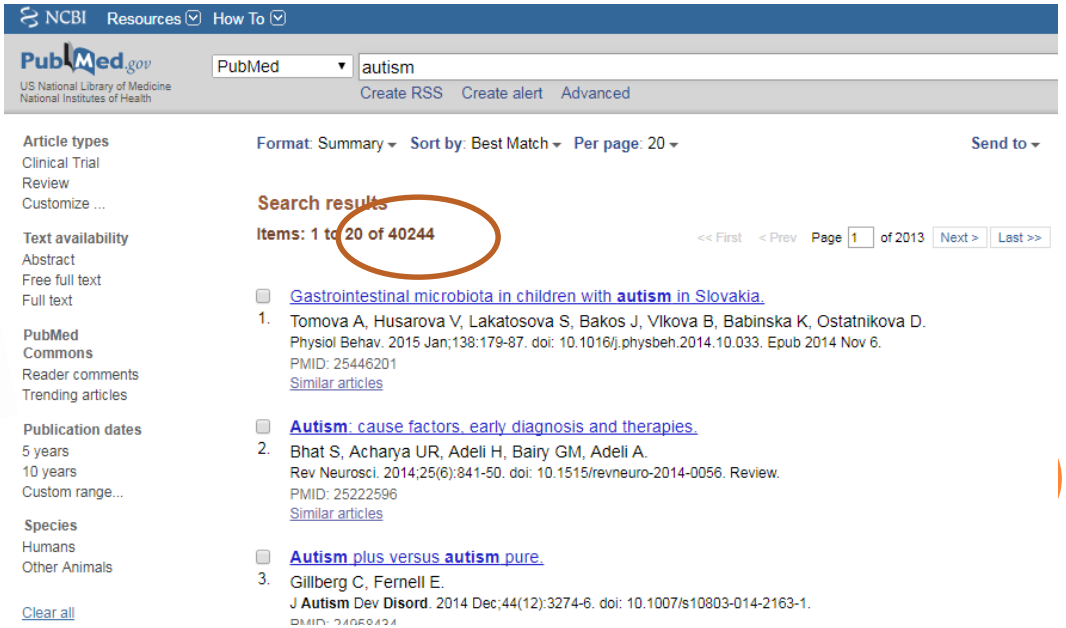
# Mistake: The topic selected for research is too **BROAD** or too **GENERAL** or too **NARROW**

When is a topic too broad?

- ✓ when it cannot be covered in detail in the assignment
- ✓ when only general statements can be written about a subject
- ✓ when there is so much information
- ✓ **Find A Broad Subject First Then Narrow It Down**

e.g., if during literature search we find100s or 1000s of reference relevant to the topic, it is too broad



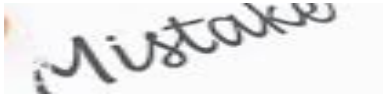
# When is a topic too narrow?

- When it is hard to research because there is so little information
- When it can be discussed in great detail in less than the required size

- e.g. if, during our literature search we find only 3 or 4 relevant items to your topic.
- (sometimes, this is because the topic is too current).


# : Research topic selected (topic) is not clear or there are other problems

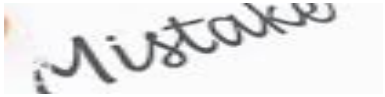
- Problem cannot be stated clearly.
- No research questions are generated.
- There is very little literature available.
- There is no potential significance/importance.
- It is not do-able within the time frame, budget.
- Sufficient data cannot be obtained
- Very new topic and nothing is known about the topic.
- Supervisors don't have much knowledge of the methods to be used,
- Instruments for the research are not available.
- No one knows how to run the instruments required for the research.
- Chemicals cannot be obtained in the specified time.
- No one to help in data analysis.




# RESEARCH OBJECTIVES ARE NOT CLEAR

- Objectives are the steps taken to answer the **research** questions or tasks needed to reach the goals of the project.
- Starting a research project without clear objectives, and without preparing an action plan with well defined specific directions, it is like starting out on a journey with no idea where you're going or how to get there. Waste of gas, time and effort.
- If research objectives are not clear, the research may result in wasting time, money, effort.

# Proper Literature search has not been conducted




# REVIEW OF LITERATURE IS NOT DONE IN A COMPREHENSIVE MANNER

A researcher must cover sufficient references to know what is known about the topic and what needs to be discovered. Mistakes are:

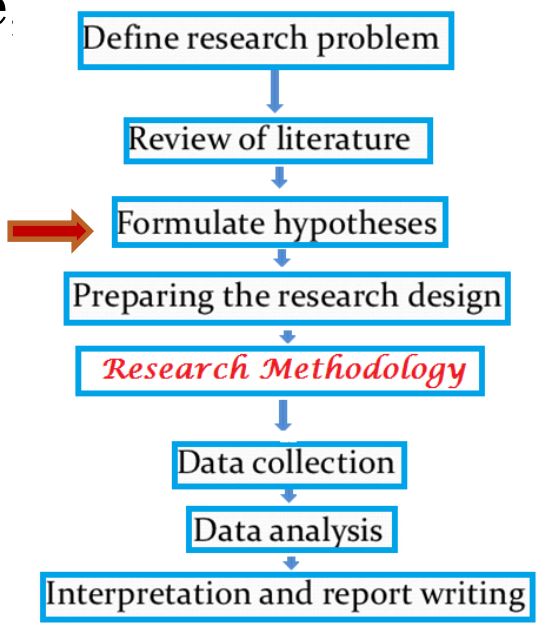
- Insufficient literature review.
- Narrowly-focused literature review.
- Using non-scholarly sources.
- Avoid authoritative sources because these are usually more difficult to read.
- Include only ‘supportive’ source.
- Spending time reading literature unrelated to the topic and the research question(s)

# Literature Review- A suggestion

- Always read the discussion section.
- Most researchers write what needs to be done.
- It is necessary to critically analyze the literature before designing a new research project

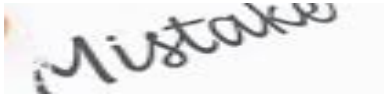
# Research Design

- A weakly designed project, with vague description about sample collection, number of samples, analyses to be done, data analysis, etc.
- This may prevent approval; and if approved it may be a major hurdle in getting meaningful results and an acceptable manuscript.
- This may cause a lot of time wasted, chemicals wasted, samples wasted and frustration, guilt, and a lot more.
- We will take a few examples:



# Mistake: No ethical approval was obtained from the IRB.


- If working on animals or humans, there MUST be an ethical approval from the Institutional Review Board (IRB).
- Researcher should not start collection of samples without the ethical approval.
- In studies on humans, if no informed consent was obtained from the participants, the research is not ethically sound.

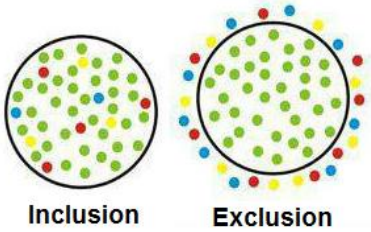


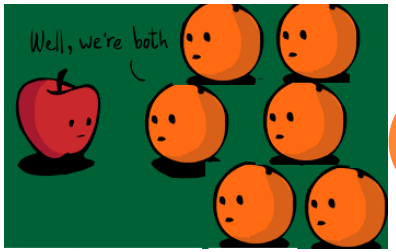

# THE INCLUSION AND EXCLUSION CRITERIA FOR THE SUBJECTS IS NOT DEFINED

- For animal, human plant or other researches, what is the criteria used for selection of the different groups for study is absolutely necessary.
- If not done properly than the results may not be correct since some of the participants, have a condition that interferes with the study parameters.





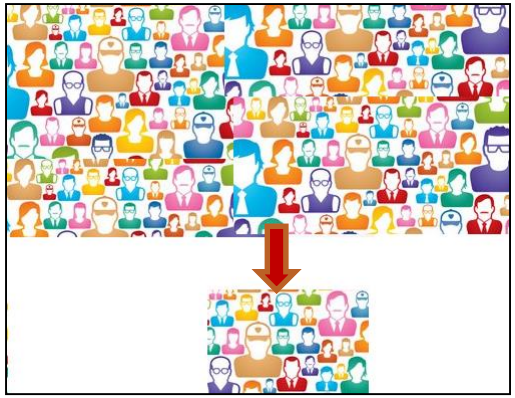


# Mistake

# Failure to perform sample size analysis before the study begins

- Sample size- necessary to get a meaningful result.
- Information about a population is inferred by studying a finite number of individuals from that population, i.e. the population is sampled.
- It is assumed that characteristics of the sample are representative of the overall population.
- Several formulas are available for the calculation of the sample size.
- Rare condition –larger sample size



**Basic formula for sample size - Continuous data**

Number of samples per group (n) = $\frac{2 x ( Z_{(1-\alpha/2)}+Z_{\beta})^2 x \sigma^2}{\Delta^2}$

Where Δ = size of difference, minimal effect of interest

α = significance level (eg 0.05)

β = power, probability of detecting a significant result (typically 80%, 90%)

σ = SD of data

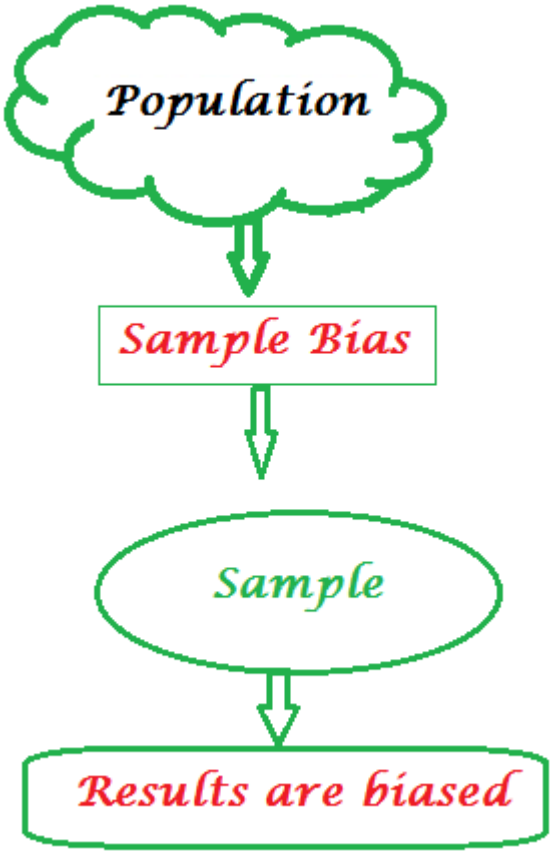
$Z_{\beta}$ = points on normal distribution to give required power and significance

$$n = (\frac{(Z_{\alpha/2})(\sigma)}{E})^2$$

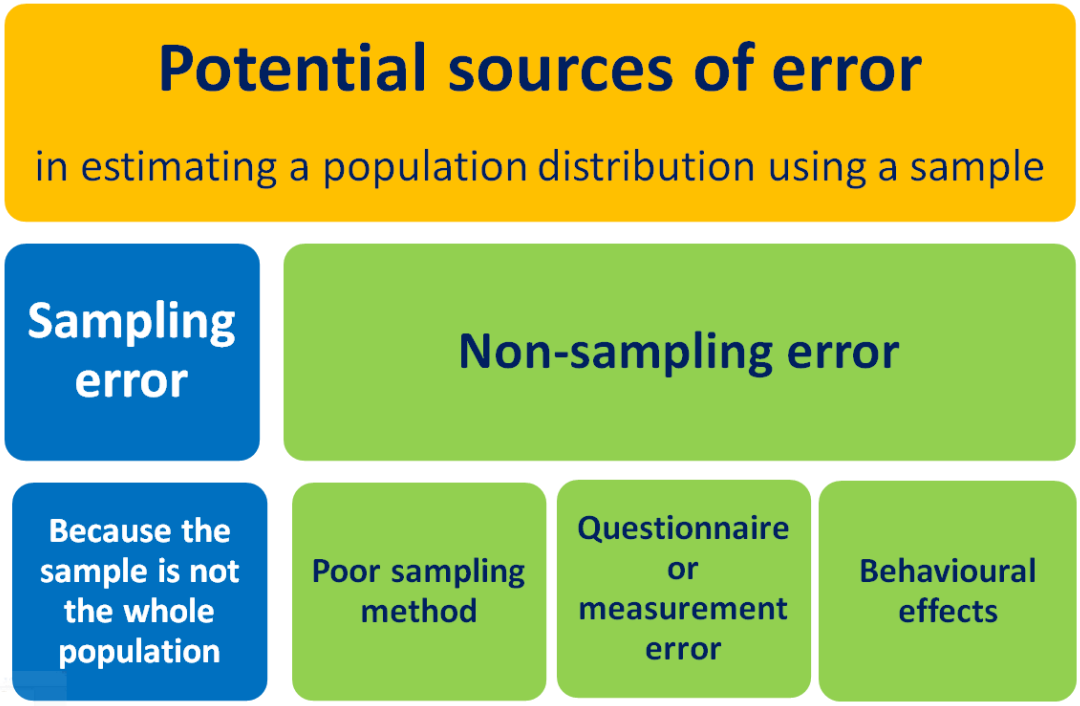
$$n = (\frac{(1.96)(100)}{20})^2 = 96.04$$

# The bias control measures are not implemented adequately

- e.g. Studying a disease prevalence in families where the disease is known to exist.
- Having mostly young people in a study on diseases that occur in advanced age groups.
- Studying a disease clinical manifestations in patients already on some treatment.
- etc

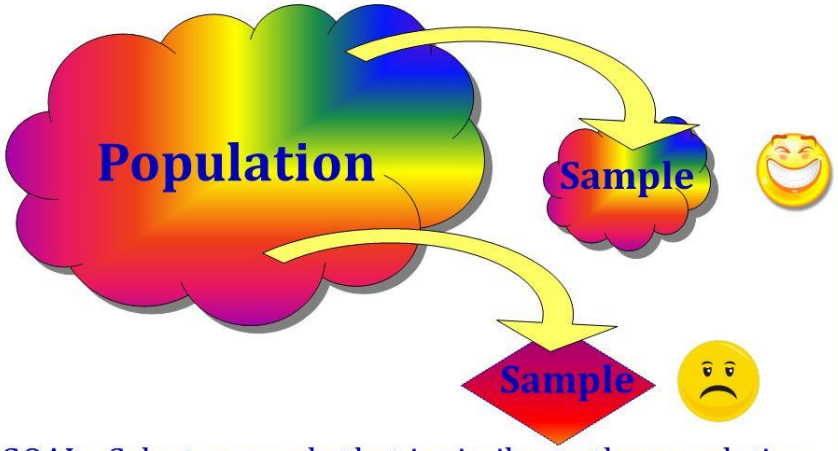


# Many sources of errors



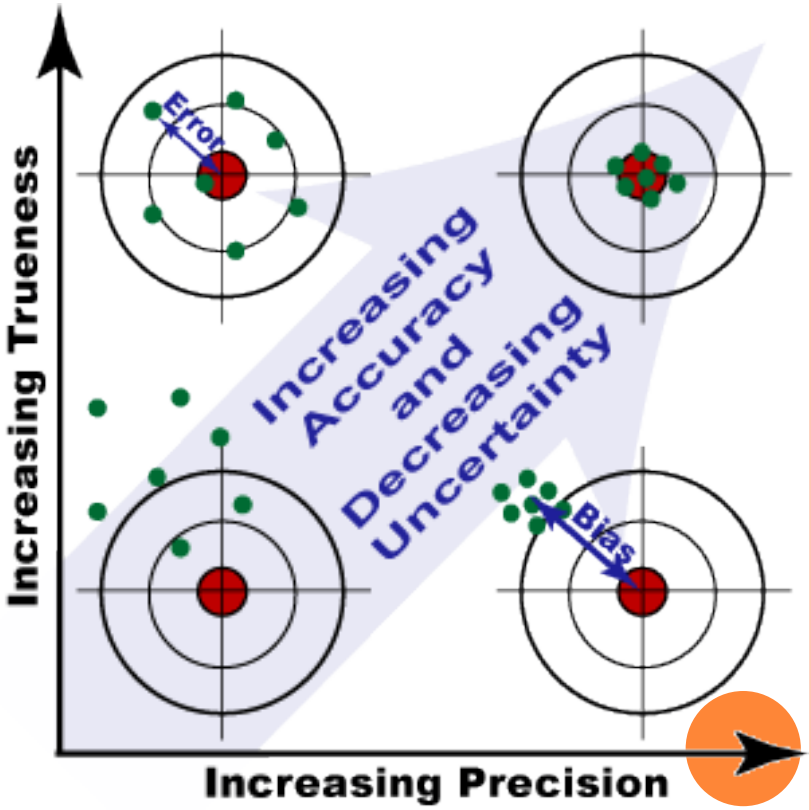

https://learnandteachstatistics.wordpress.com/2014/09/04/sampling-and-non-sampling-error/

## Sampling




GOAL: Select a sample that is similar to the population, only smaller





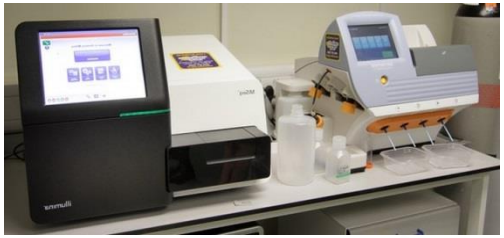
# How to reduce bias?

- Take a large sample
- Use random sampling methods, as apposed to convenience sampling methods.
- Try to include all available subjects

# Mistakes related to research methodology

# Mistakes related to research methodology

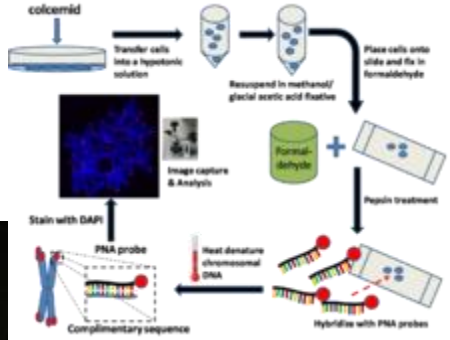
- Instruments included not available or not working





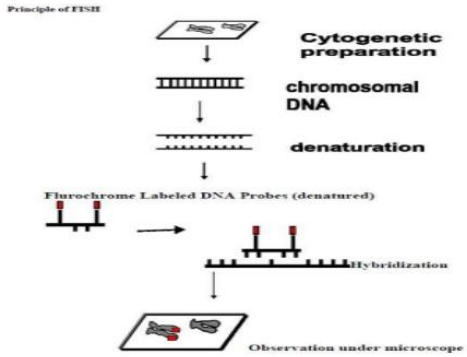
# No expert available to run the instruments.

LM (1000X) SEM (100000X) TEM (200000X

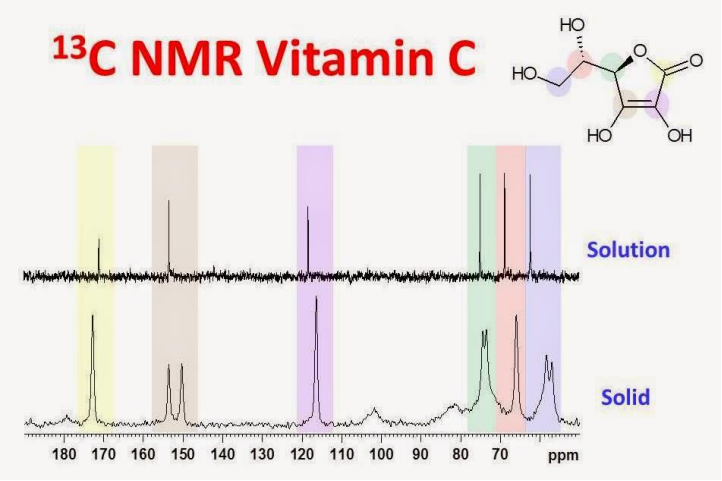



## FISH

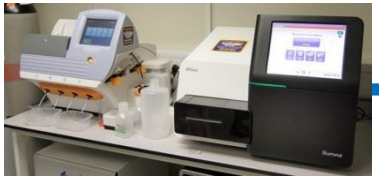
- A technique that hybridizes a DNA nucleic acid probe to a target DNA sequence contained within a cell nucleus.

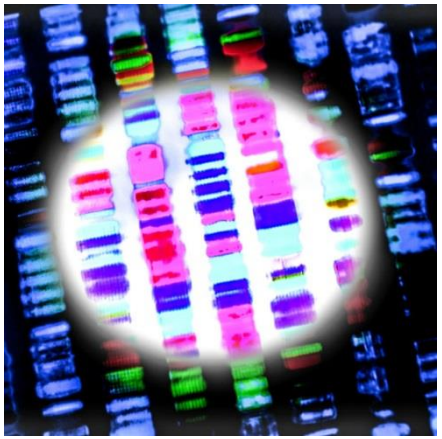


# No expert available to run the instruments.

# No one can interpret the results.



# Much longer time needed to complete the study than anticipated in the research design.

Total Study period

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Months |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Started the research

Need 10 months to complete the experiment

# Not enough samples available for the condition under study.

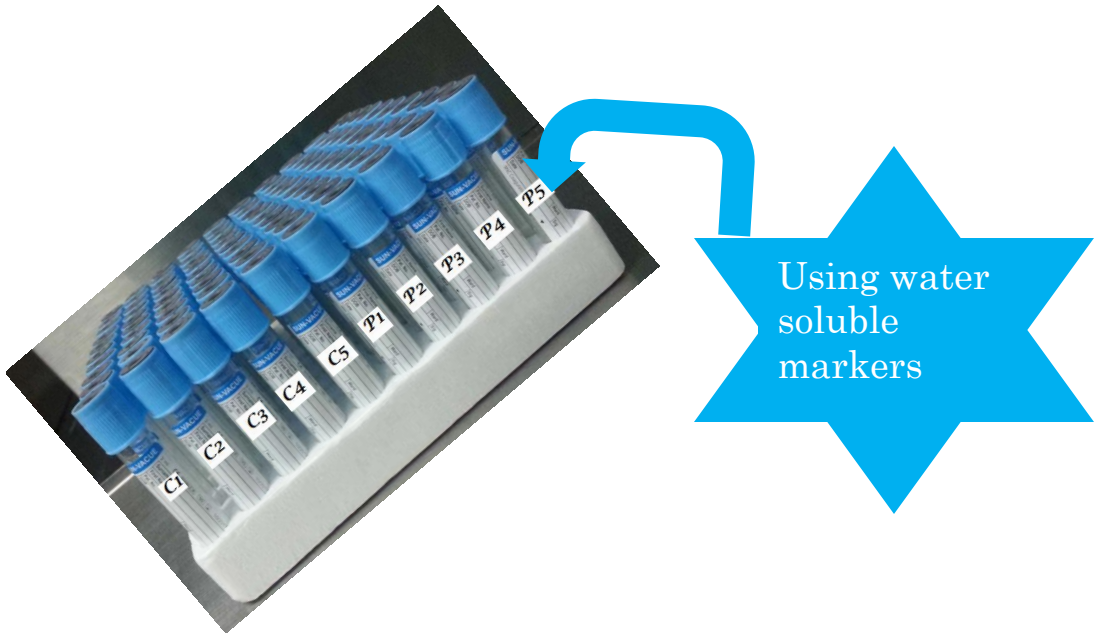
- Example 1:
  - Frequency of disease 0.1%----(1 in 1000)
  - You need 100 samples
  - Need time to collect so many samples.
  - Necessary to be sure before starting the experiments if the samples are available.
- Example 2:
  - You have to treat patients/ animals/plants for 1 year.
  - Study the outcome of pregnancy (9months)

# Defects in the method of sample collection

- Examples:
  - Right tubes not used
  - Saliva collected soon after patient eats
  - Blood collected for sugar, lipid estimation, after patients has eaten food.
  - Need serum, but collected the blood in an anticoagulant tube (plasma)
  - Collected samples and no fridge or container available to store/transport the samples
  - Collecting to study RNA but not in *RNA later* tubes
- Make sure you know read every thing about your parameters under study before you start collecting samples.

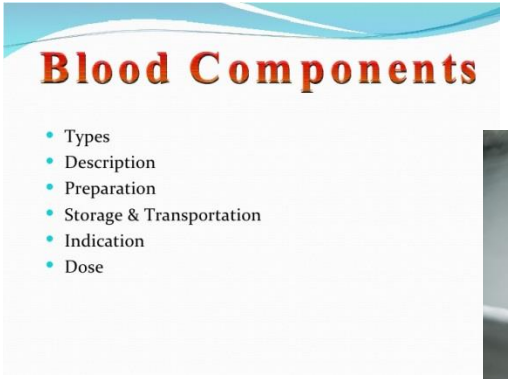
# Labelling the samples

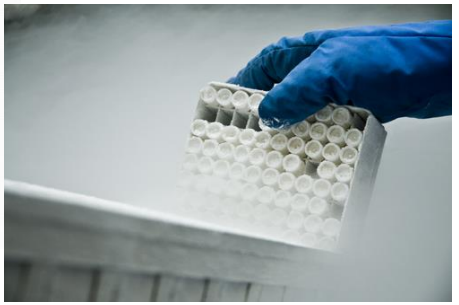
- Very important to devise a plan of how to label the samples, before collecting samples.
- Many mistakes occur when making aliquots of the sample.



# Defects in the method of sample storage

- Storing at $4^0$C, when samples should have been frozen
- Leaving at room temperature when the samples should have been collected in ice.
- Leaving at $4^0$C for long time.
- Sample contamination with environmental agents.



# Errors in measurements

## What type of error?

A group of students took turns to take measurements and did not use the same tools or methods.

MrT did not calibrate (set up) the pH probe properly, so every reading was pH 0.5 too high.

A student did not clean the probe in-between measurements, so they contaminated each solution.

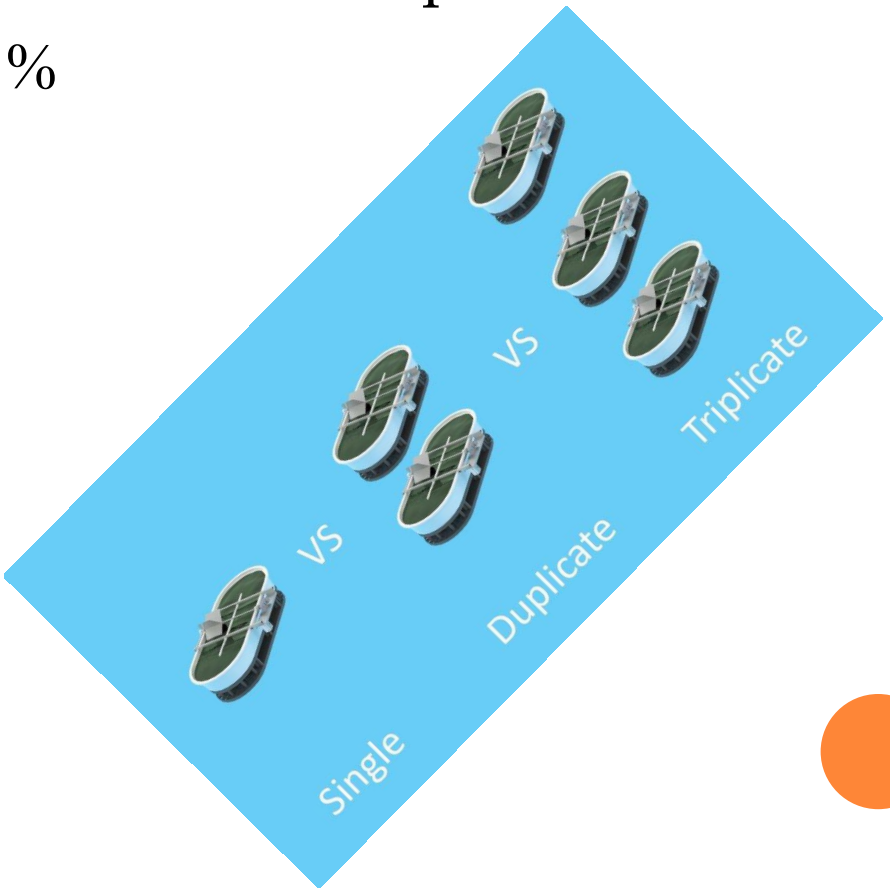
Something was left on the digital balance for every recording, so the results were always too high.

Students were using the digital balance, but the breeze from the AC kept changing, giving different readings every time.

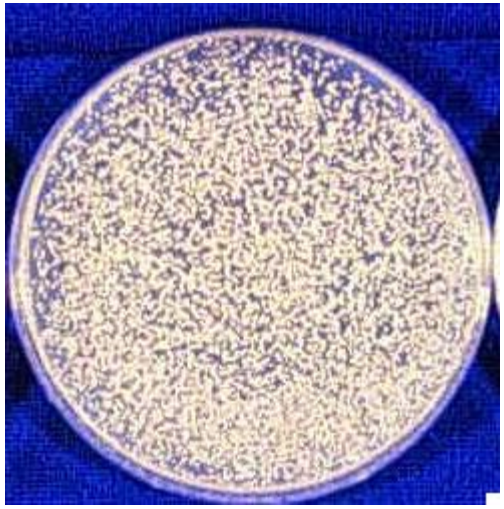
http://slideplayer.com/slide/7070515/

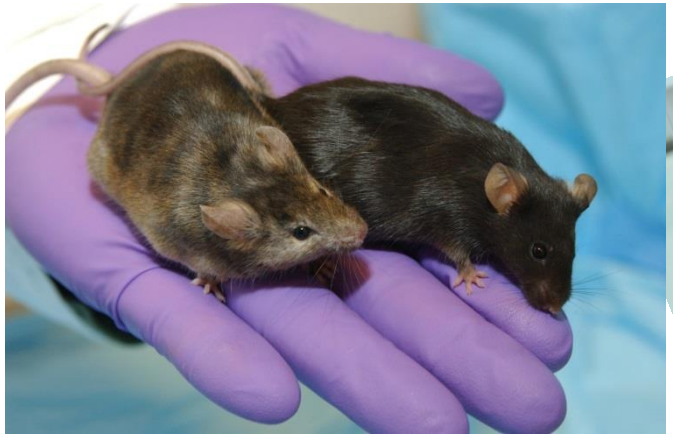
# Not working in duplicates/triplicates

- Single measurements are prone to be wrong
- Always work in triplicates o atleast duplicates
- Coefficient of variations %



# Not protecting your self/sample from contamination





# Defects in the method of storage of the required chemicals.

- Chemicals stored under wrong conditions
- E.g. kept in fridge when it should be stored frozen
- Freezing a chemical when it should be kept at $4^0$C

# Disposal of chemicals

- Throwing chemicals in the sink
- Leaving inflammable liquids in the lab.
- Leaving chemicals exposed to sunlight.
- Tissue cultures not stored in liquid nitrogen

## Chemical Storage

- Proper storage is required for all chemicals following the procedures of the Safety Manual (Page 43):

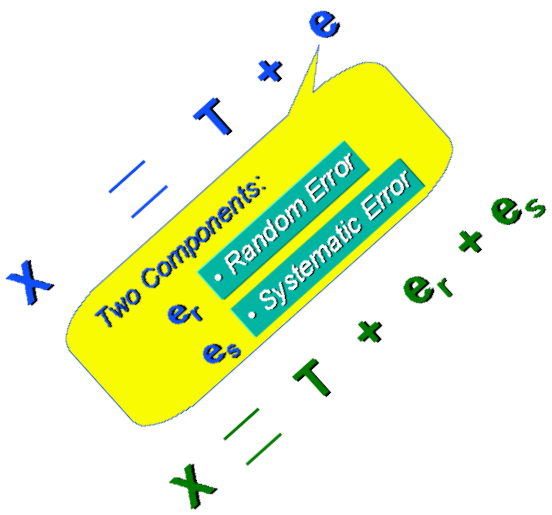
– Solids
- Oxidizers
- Flammables
- Water reactives
- Others

– Liquids
- Acids
- Oxidizers
- Flammable/combustible
- Corrosive materials
- Perchloric acid

-Gases
- -Toxic
- -Oxidizers
- -Flammable

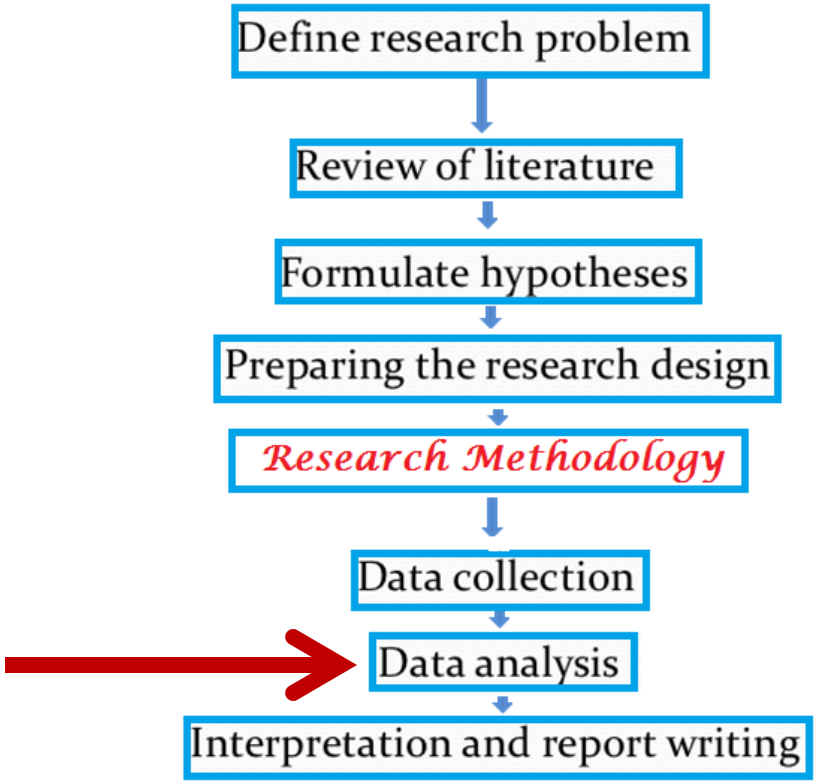
# Errors of measurement methods

- Error of measurement methods are not identified or not reported
- Instruments and methods are not standardized against a standard-within batch and between batch measurements
- others




# Mistakes in data collection

# Mistakes in data Analysis

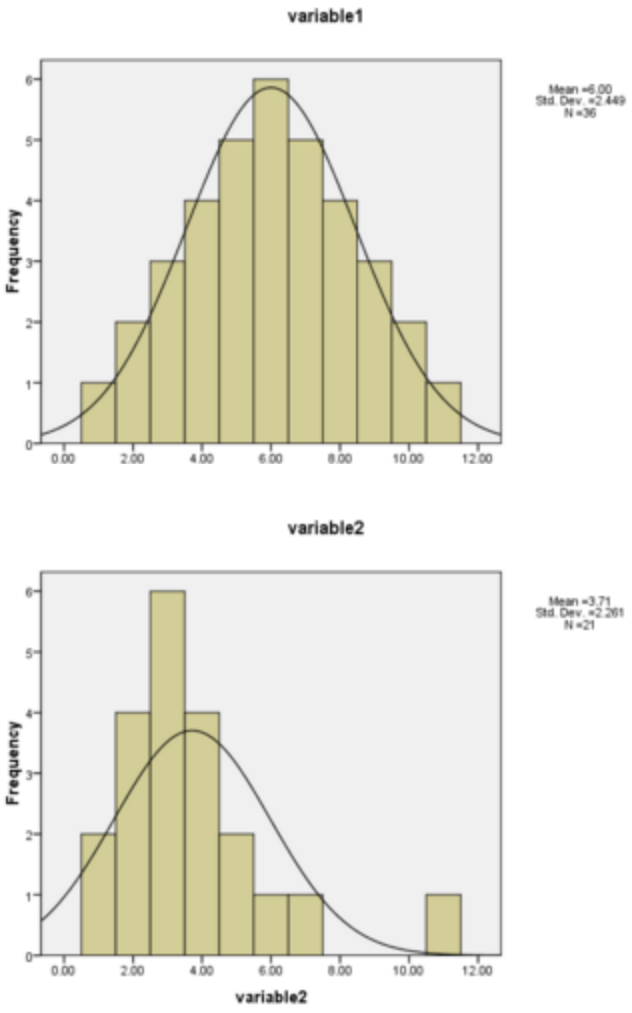


# Errors in statistical methods

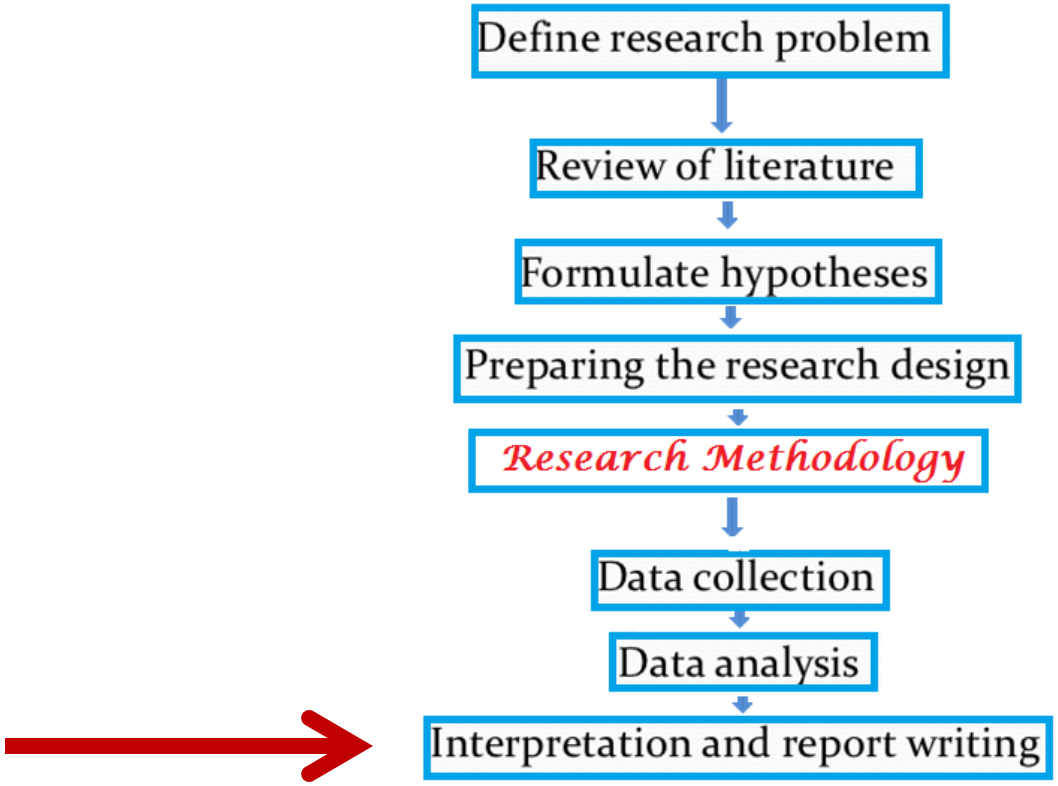
- Some mistakes:
  - Not using any statistics
  - Not having enough samples to do statistics
  - Using wrong statistics
  - Not getting the significance of difference between groups (p value)
- Consult a statistician when designing the study.
- Learn some statistics

# Failure to examine for normality of data

- Many statistical tests [correlation, regression, t tests, and analysis of variance (parametric tests), are based on the assumption that the data follows a normal Gaussian distribution.
- To see if the data obtained is normal:
  - Look at histogram, Skewness and Kurtosis simultaneously.
  - The Kolmogorov-Smirnov test (K-S) and Shapiro-Wilk (S-W) test are designed to test normality by comparing your data to a normal distribution with the same mean and standard deviation of your



# Mistakes in data interpretation and writing



# Mistakes during writing the manuscript/thesis etc

- Copy/paste in writing,---plagiarism
- Copying figures from papers without referring to them
- Asking someone else to write ,---plagiarism
- Cheating from someone
- Self plagiarism
- Mistakes in spellings/grammer
- Making up data
- Excluding some data (report missing data, dropped subjects etc)
- etc

# If the weaknesses of the study is not pointed out

- Others will pick up the weaknesses.
- Always better to say what are the weaknesses before anyone else points.
- e.g inadequate number of samples

*Thank you for listening*