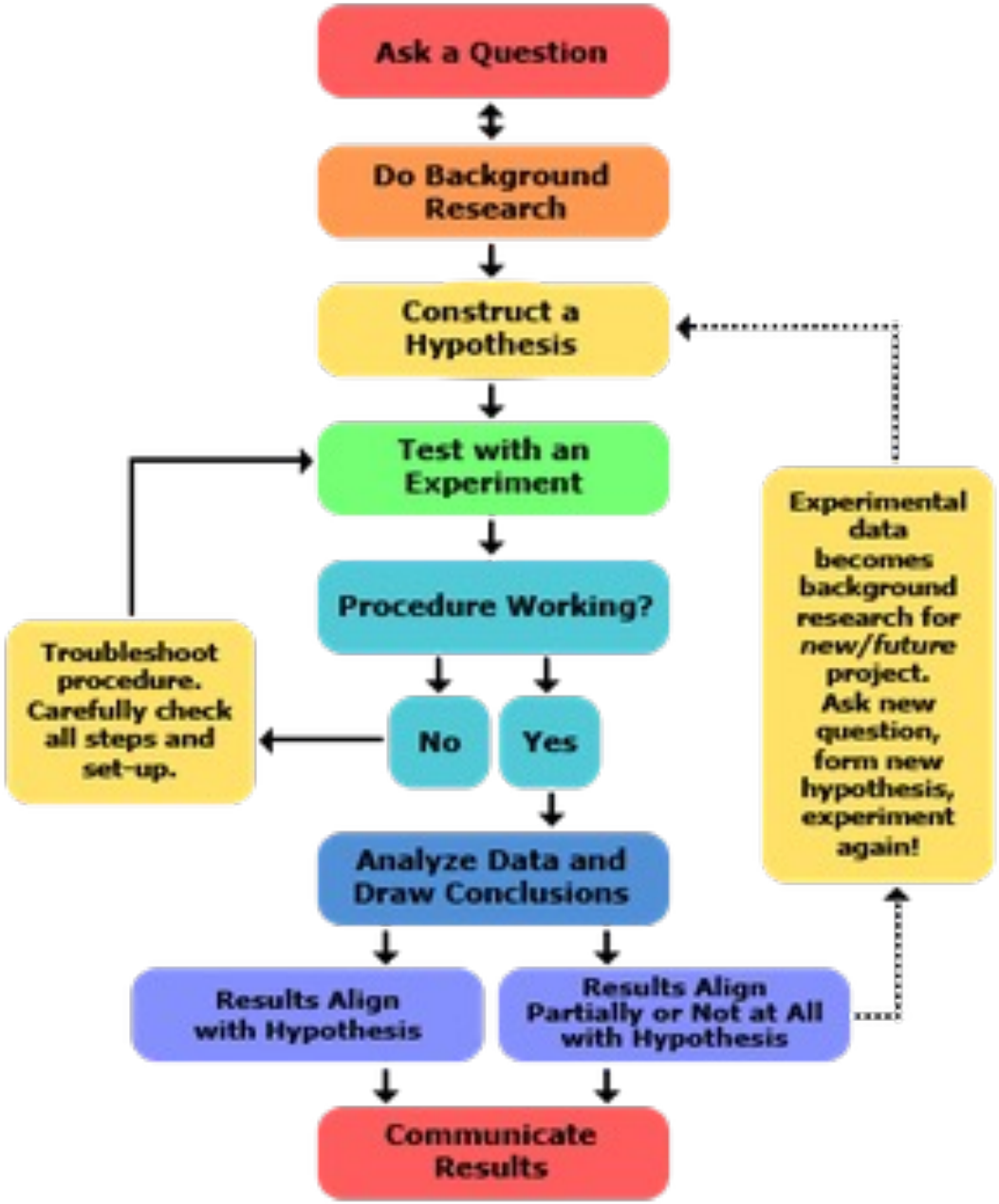
CUCRID Research Clinic Series
Foundational Research Skills- *Scientific Method; Essential Techniques for Research & Communication Skills*

- Emeka E.J. Iweala, Ph.D
- Department of Biochemistry/Covenant Applied Informatics & Communication Africa Centre of Excellence,
- Covenant University,

- May 29, 2024

Scientific Method

- **Ask a question** - about something that you observe: How, What, When, Who, Which, Why, or Where?
- **Background research plan**
  - Identify the keywords in the research question;
  - Search/document information on keywords using the library or internet
- **State both hypothesis and the resulting prediction to be tested.**
  - Experimental data either supports or does not support hypothesis
- **Test with Experiment**
  - Experimental Procedure
  - List of materials
  - Conducting the experiment (s)



Scientific Method

- **Analyse Data & Conclude**
  - Review/analysis of measurements/data to see if they support hypothesis
  - Calculating and summarising data
  - Summarising data using averages, ratios, percentages, error, significance, individual data points etc
- **Selection of appropriate statistical method**
  - Aim and objective of the study,
  - Type and distribution of the data used
  - Nature of the observations (paired/unpaired).
- **Communicate Results**
  - Final collation and report of research into one large document, publishing in a scientific journal and presenting results on a poster/oral at conferences.

Scientific Method: Research Ethics

Principles and ethical considerations in research draw on: **The Belmont Report** and include:

- **Respect for persons - autonomy and protecting those with diminished autonomy**
- **Beneficence and non-maleficence**
- **Justice**
- **Informed consent**
- **Confidentiality and data protection**
- **Integrity**
- **Conflict of interest**

- Strategies, processes or techniques for collection of data/evidence for analysis to uncover new information
- Different research methods use different tools for data collection
- **Qualitative Research**
  - Interviews; Focus groups; Observations; Document analysis; Oral history/Life stories
- **Quantitative Research**
  - Surveys or questionnaires; Observation; Document screening
- **Mixed Methods Research** (**Qualitative** and **Quantitative)**.
  - Combining and analysing data with deeper contextualised insights.
  - Enables **Triangulation,** or verification, of data from two or more sources.
- **Experimental Research**
  - Experiments have four elements - manipulation, control, random selection and random assignment
  - Involves the use of laboratory techniques

- Procedures and tools used in scientific research and experimentation across various fields.
- Crucial for obtaining reliable data, analyzing samples, and drawing conclusions
- Some common laboratory techniques and methods:
- Microscopy
- Spectroscopy
- Electrophoresis
- Chromatography
- Extraction
- PCR
- Sequencing
- Cell culture
- In vitro/In vivo

Communication skills – Scientific writing

- ***“If you can't explain it simply, you don't understand it well enough” (Albert Einstein)***
- Common modes of scientific communication?
  - Writing scientific papers
  - Making a scientific or technical presentation
  - Writing research or project proposal
- Effective scientific writing is divided into - Writing Style and Writing a Manuscript
- Most important things are
  - Audience(s)/ Reader(s)
  - the language they use - need clear, accurate language with straightforward non-technical vocabulary that describes the research.
  - abbreviations they are familiar with - unfamiliar jargon, abbreviations and acronyms not necessary
  - What is interesting and relevant to them?
  - Audiences need structure, signposts and logical flow.

- A good writing style contains the following:

❑ Varying sentence and paragraph length

❑ Familiar (nontechnical) vocabulary

❑ Blend of the active and passive voice

- Consider using the active voice when appropriate.
- Avoid smothered verbs.
- Keep acronyms and abbreviations to a minimum; define any unfamiliar ones at first use.
- Use tenses consistently.
- Don’t be afraid to use familiar (and shorter) nontechnical words.
- Think about paragraph construction and ways to make sentences flow from one to the next.
- Aim to organise the chapters/section of your documents in a logical sequence.
- Remember that the appearance of your document is important, white space being key.

- **Planning to Write a Manuscript**
  - Write the methods first
  - Prepare key figures and tables
  - Write the ‘problem statement’
  - Use an electronic mindmap - enter the four sections of a manuscript on your map: introduction, methods, results and discussion.
- **Introduction section (What is the problem addressed?)**
  - Provides relevant information - Not a literature review!
  - Demonstrate relevance to science
  - Deliver a clear and logical rationale/argument in support of the research
  - Summarise the question/hypothesis, overall method and why the study is important.

Scientific writing: Writing a manuscript

- **Materials & Methods section (How did we solve the problem?)**
  - Method(s) must be described in detail and **repeatable** by others – major reason for rejection of manuscripts!
  - A recipe – copied from an original author, modified or newly developed a new method
  - Methods should include the following:
    - selection and source - materials/animals/volunteers
    - study design – e.g temperature, time, dose, species
    - outcome measures
    - statistics - techniques, randomisation, power, specified p values
    - ethics - approval if required (end of participant section)
    - subheadings – can be similar to the corresponding results
    - tables/flow charts/diagrams if needed/allowed.

Scientific writing: Writing a manuscript

- **Results section (What did we find?)**
  - Should present most important/relevant results in a logical sequence
  - Provide good figures/tables with a legend for relevant methods
  - Should avoid wordy repetition of information presented in figures/tables.
  - Should avoid methods (except in the legends) and references
  - Term '*significant*' should be used for statistical findings.
  - Avoid statements such as '*markedly increased*' or '*greatly reduced*', but '*three-fold increase*' or '*95% reduction* '*could* be used.
- **Discussion section (**What does it mean?**)**
- Structured to include the following:
  - summary of main findings and implications
  - strengths and weaknesses of study and in relation to other studies/theories
  - unanswered questions and future direction.
  - structured argument
  - Succinct interpretation of results
  - Balanced conclusion (Summary of what we have learnt)

Scientific writing: Writing a manuscript

- **Abstract (What was done in a nutshell?)**
  - An accurate reflection of the manuscript.
  - Abstract quickly answers four critical questions in few words - **Why the study? What was done? What was found? What does findings mean?**
  - **Background**
  - **Methods**
  - **Results**: up to 50%. Major result summarised
  - **Discussion**: usually not needed.
  - **Conclusion**: essential and similar to main conclusion in the manuscript
- **Other sections**
  - **Title** (for readers' orientation)
  - **References** (Whose previous work did we rely on?)
  - **Appendices (**Additional information)

Communication skills – Publishing in High Impact Journals

- Crucial aspect of academic & Professional success
- Validates the quality and significance of research
- Enhances professional reputation
- Opens opportunity for collaboration
- Increases the visibility of research work
- Promotes chances of grant application success
- Can be challenging and competitive.

Strategies for publishing in high-impact journals

- Choosing the Right Journal
- Conducting Rigorous Research
- Crafting a Compelling Manuscript
- Investing in Professional Copy Editing
- Engaging in Peer Review
- Collaborating and Networking
- Persistence and Resilience
- Staying Updated With Publishing Trends


Thank You for Listening