Introduction to Biology Laboratory

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Laboratory Safety

- Personal safety is an important aspect of both the engineering and nursing professions.
- As engineers and nurses you are responsible for your own safety as well as the safety of those around you.
- 95% of safety is common sense. If something appears to be unsafe, it probably is and should be done differently.

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MSOE's Lab Safety Policy

- Read the "Laboratory Safety Policy" that I will distribute today and sign and return the last page.
- Comply with this policy in lab.
- If you have any safety concerns during lab, do not hesitate to bring them to my attention.

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Scientific Experiments

- Biology is the study of life and therefore is closely related to both the biomedical engineering and nursing professions.
- Biologists observe living systems, propose explanations for their observations and determine if their explanations are correct.
- Engineers apply these results to create medical devices.
- Nurses apply these results in clinical patient care and are often use medical devices.

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The Scientific Method

- Scientific investigation is a way of testing possible explanations for observations.
- Scientific method is the process by which scientific investigation is accomplished and is used in every type of research (not just biology).
- The scientific method tpyically includes the following steps…

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Selected Scientific Steps

- Asking Questions
  - Generally scientists ask questions about things they are interested in.
  - Yet not all questions lead to scientific investigation.
  - Questions appropriate for the scientific method must be well-defined, measurable and controllable.
  - Questions that can be invested change over time as human technology and understanding develop.

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Steps (continued)

- Developing Hypotheses
  - Hypotheses are tentative explanations for what is observed.
  - They are generally developed based on prior knowledge (educated guesses).
  - A scientifically useful hypothesis must be testable and falsifiable (able to be proved false).
  - To satisfy this requirement, it must be possible for experimental results to disprove the hypotheses.
  - Note that most hypotheses can never be proved true.

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Steps (concluded)

- Designing Experiments
  - The most creative aspect of science is designing a test of a hypothesis that will provide clear evidence to falsify or support a particular explanation.
  - An experiment involves defining variables, developing procedures, and determining controls to be used.
  - Once an experiment is defined, the investigator predicts the expected outcome.
  - The following slide lists some steps involved in deigning experiments.

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Identify the Variables

- Dependent: The variables measured, counted or observed in response to the experimental conditions.
- Independent: Variables manipulated to influence the dependent variables in order to test the hypothesis.
- Controlled: Non-independent variables kept constant so as not to affect the outcome of the experiment.
- Cofounding: Non-independent variable that can't be conrolled.

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Designing Procedures

- Procedures are the sequence of steps to be performed in the experiment, and should be recorded before the experiment is done. Here are some topics that should be considered when developing procedures include:
  - Level of treatment: This is the value set for the independent variable.
  - Replication: Generally the same procedure is repeated several times.
  - Control: When the independent variable is held at a constant value or omitted.
  - Statistics: Often used to determine if your hypothesis was proved false or not. Generally not required in this course.

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Making Predictions

- A prediction is based on a particular experiment designed to test a specific hypothesis and are written in the form of "if/then" statements.
- If the results match the prediction, the hypothesis is supported.
- If the results do not match the prediction, the hypothesis is falsified (refuted).

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Communicating Results

- Scientific results must be conveyed to interested audiences for science to be useful.
- Scientists use scientific reports and papers (journal articles) for this.
- The heart of the scientific paper is the results of an experiment.
- These are most often presented in the form of tables and graphs and should clearly relate to the hypotheses being tested.

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Laboratory Notebooks

- Laboratory notebooks (essentially the same as Engineering Logbooks and related to patient charts and medical records) provide legal documentation.
- You may find it useful to think of them as diaries for your professional life.
- It is important to start developing the skills of using a laboratory notebook early in career development.
- Notebooks for "scientific" classes like this one should include the following…

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Notebook Contents

- Your name, address and phone number as well as the class name should be on front cover.
- A copy of the "Introduction to Laboratory Notebooks" handout.
- A copy of laboratory safety guidelines.
- Records of your experimental work.
- A Table of Contents **at the back of the book** and going towards the front.

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Experimental Records

- Introduction. Brief overall description what you intend to study.
- Specific hypotheses and predictions.
- Methods (Procedures). These should be prepared at a level of detail such that the work can be reproduced by an equally educated and skilled individual.
- Results (may be summarized in computer generated graphs or tables), including statistical analyses.
- Conclusions regarding hypotheses based on your work.
- Any other interesting observations, etc. Particularly anomalies (things you didn't expect).

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Some Specific Items

- Sketches & Graphs
- Data
- References
- Attachments

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Sketches and Graphs

- Simple sketches, such as those illustrating experimental procedures, can and should be made in the book.
- Photographs are also sometimes included.

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References

- References should be cited to the source of the material when it is impractical to include the information directly in the notebook.
- These include computer files and web sites.
- Be sure references can be easily located (so your work can be reproduced).

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Attachments

- Attachments made in the notebook must be made with an adhesive so as to be permanently fashioned (tape or glue – no paperclips or staples).
  - In addition, titles, references, and other pertinent labeling (specific in nature) should be made above, below, or marginally so that if the attachment is lost, defaced, or becomes illegible, some identification will remain in the book.
  - If material is also stored in electronic format, reference to location of this information should be included.
  - All attachments should be trimmed or folded to remain well within the borders of the notebook when closed. Double-sided attachments should be photocopied so that each side can be attached on a separate page.
  - Attachments should be signed and dated across the edge.

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Couple Sections

- The individual sections (Introduction, Hypotheses, Methods, Results, Conclusions) should be tightly coupled.
- That is, the methods should be designed to support or refute specific hypotheses, results should follow directly from the specific procedures and conclusions should be based on the results and directly address support or reject hypotheses.

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Reproducibility & Reporting

- The goal of the methods and results sections is to provide enough information so that a person with your knowledge and skills could reproduce your work using just the information in your notebook.
- When done correctly these sections also provide a valuable (essential) resource for writing a final report on your work.

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What Shouldn't be Included

- Homework solutions (unless related to laboratory work)
- Blank pages
- Personal reminders (grocery lists, etc.)
- Inflammatory statements ("Dr. Tritt is an idiot," etc.)
- Other "junk"

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Legal Requirements

- Permanently bound pages.
- Factory numbered pages.
- All entries in ink.
- Each entry signed and dated (at bottom of each page).
- New entries (days) start at top of new page.
- Unused spaced marked "Abandoned," initialed and dated.
- Corrections lined out, initialed and dated.

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