Name____________________ Date______________

Unit 1 – Biology Notes

Inquiry

B-1.1 Generate hypotheses on the basis of credible, accurate, and relevant sources of scientific information.

Key Concepts: hypotheses, sources of scientific information

- ✓ A **hypothesis** is a reasonable explanation of an observation or experimental result or a possible answer to a scientific question that can be tested. The hypothesis may or may not be supported by the experimental results. It is often stated in terms of an independent and a dependent variable—or a "cause-effect relationship." Examples of hypotheses might include:
  - ✓ If a leaf has a greater surface area, then the rate at which it produces oxygen may increase.
  - ✓ If a cell has a higher surface area, diffusion occurs faster.
  - ✓ At warmer temperatures, mold will grow faster on bread

- ✓ **The results of an experiment cannot prove that a hypothesis is correct**. Rather, the results support or do not support the hypothesis. Valuable information is gained even when the hypothesis is not supported by the results.

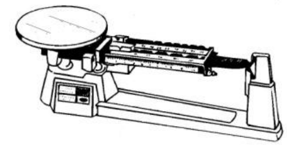
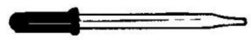
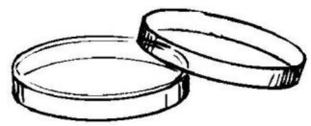
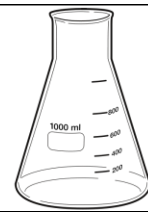
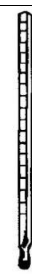
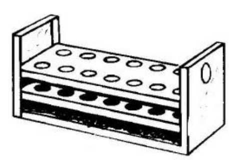
- ✓ When hypotheses are tested over and over again and not contradicted, they may become known as **laws or principles**.

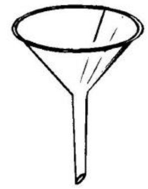
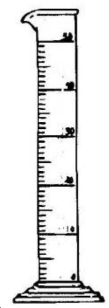
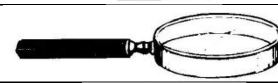
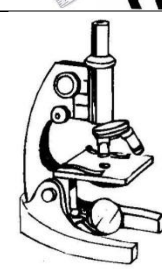
- ✓ You must use ***credible*** (trustworthy), ***accurate*** (correct – based on supported data), and ***relevant*** (applicable, related to the topic of the investigation) sources of scientific information in preparation for generating a hypothesis. These sources could be previous scientific investigations science journals, textbooks, or other credible sources, such as scientifically reliable internet sites.

B-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

Key Concepts: laboratory apparatus, laboratory technology, laboratory techniques,

✓ Use appropriately and identify the following laboratory apparatuses and materials:

Balances, triple beam	
Beakers (50mL, 100 mL, 250mL)	
Pipettes / droppers	
Petri dishes	
Erlenmeyer flasks	
Stirring rods, spatulas, scissors, chemical scoop	
Thermometer	
Test tubes, clamp, holder, and rack	  

Test tube Brush	
Forceps	
Funnels	
Graduated cylinders (10 mL & 100 mL)	
Hand lenses (magnifiers)	
Watch glasses,	
Hot plates	
Measuring tools (rulers, meter stick, meter tapes, stop watch or timer)	
Microscopes (compound & dissecting)	

Lab aprons, safety goggles, gloves	

B-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

Key Concepts:
Reading scientific measuring instruments:
graduated cylinders, balances, spring scales, thermometers, rulers
Measurement data
Metric units
Precision and accuracy

- ✓ The measurement scale on the instrument should be read with the last digit of the recorded measurement being estimated.
- ✓ Record data using appropriate metric units (SI units). You should be able to use prefixes; **milli, centi, kilo.**
- ✓ The more decimals in the recorded measurement, the greater the precision of the instrument.
  - ✓ An instrument that can be read to the hundredths place is more precise than an instrument that can be read to the tenths place.
  - ✓ A 100 mL graduated cylinder that is marked in 1 mL increments can be read exactly to the ones place with the tenths place being estimated in the recorded measurement.
  - ✓ A 10 mL graduated cylinder that is marked in 0.1 mL increments can be read exactly to the tenths place with the hundredths place being estimated in the recorded measurement.
  - ✓ The 10 mL graduated cylinder, therefore, is more precise than the 100 mL graduated cylinder.

- ✓ The terms ***precision*** and ***accuracy*** are widely used in any scientific work where quantitative measurements are made.
  - ***Precision*** is a measure of the degree to which measurements made in the same way agree with one another.
  - The ***accuracy*** of a result is the degree to which the experimental value agrees with the true or accepted value.

- It is possible to have a high degree of precision with poor accuracy. This occurs if the same error is involved in repeated trials of the experiment.

B-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

Key Concepts:
Scientific investigation: Hypothesis, Independent variable, Dependent variable
Methods of control: Controlled variable, Control group

The steps in designing an investigation include:

1. Stating the purpose in the form of a testable question or problem statement
2. Researching information related to the investigation
3. Stating the hypothesis
4. Describing the experimental process
5. Planning for independent and dependent variables with repeated trials
6. Planning for factors that should be held constant (controlled variables)
7. Setting up the sequence of steps to be followed
8. Listing materials
9. Planning for recording, organizing and analyzing data
10. Planning for a conclusion statement that will support or not support the hypothesis

- ✓ Scientific investigations are designed to answer a question about the relationship between two variables in a predicted "cause-effect relationship."
- ✓ The statement that predicts the relationship between an independent and dependent variable is called a ***hypothesis.***
- ✓ The ***independent variable*** is the variable that the experimenter deliberately changes or manipulates in an investigation.
- ✓ The ***dependent variable*** is the variable that changes in an investigation in response to changes in the independent variable.
- ✓ Understand that the **independent variable** is the "cause" and the **dependent variable** is the "effect" in the "cause-effect" relationship that is predicted.
- ✓ All the other possible variables in the investigation should be held ***constant*** so that only one variable (the independent) is tested at a time. **The variables which are held constant are called *controlled variables*.**

- ✓ The investigator should conduct repeated trials to limit random error in measurements.
- ✓ When appropriate, a ***control group*** is set up as a basis of comparison to test whether the effects on the dependent variable came from the independent variable or from some other source.

B-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics, graphs, models, and/or technology.

Key Concepts:
Data Graphs
Controlled scientific investigation Direct and Inverse variations (proportion)
Formulas Models
Technology

- ✓ Organize data which is collected from a controlled scientific investigation.
- ✓ Data should be organized in charts which list the values for the independent variable in the first column and list the values for the dependent variable in a column to the right of the independent variable.

Example Charts:

Independent Variable	Dependent Variable

(Or)

Independent Variable				Dependent Variable
	Trial 1	Trial 2	Trial 3	
First value				
Second value				
Third value				
(other values)				

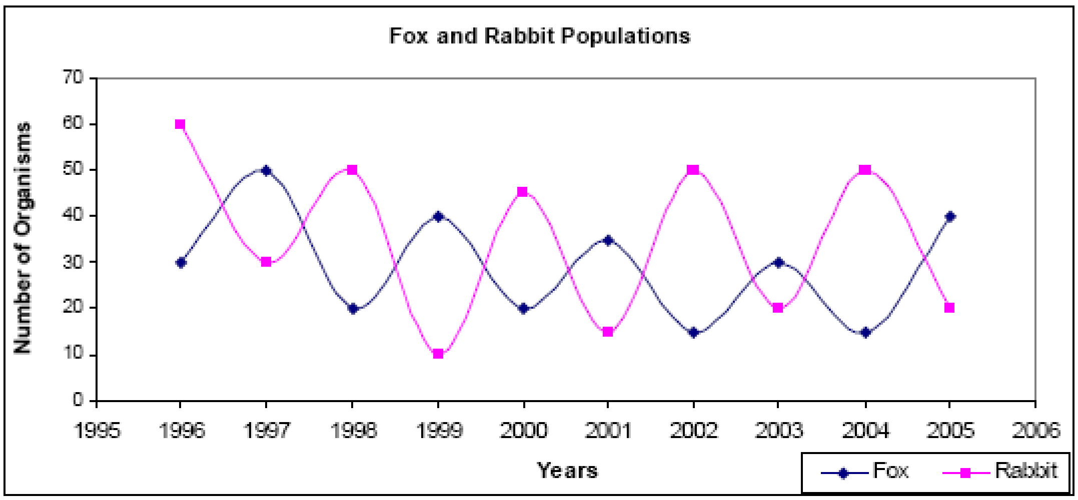
- ✓ Use graphs to organize data from controlled investigations.
- ✓ Data should be recorded on a graph with the independent variable plotted on the "X" axis and the dependent variable plotted on the "Y" axis.
- ✓ Choose scales for both the horizontal axis and the vertical axis.
    - ✓ There should be two data points more than is needed on the vertical axis.
    - ✓ The horizontal axis should be long enough for all of the data points to fit.
    - ✓ The intervals on each axis should be marked in equal increments.
    - ✓ Label each axis with the name of the variable and the unit of measure.

- ✓ Title the graph.

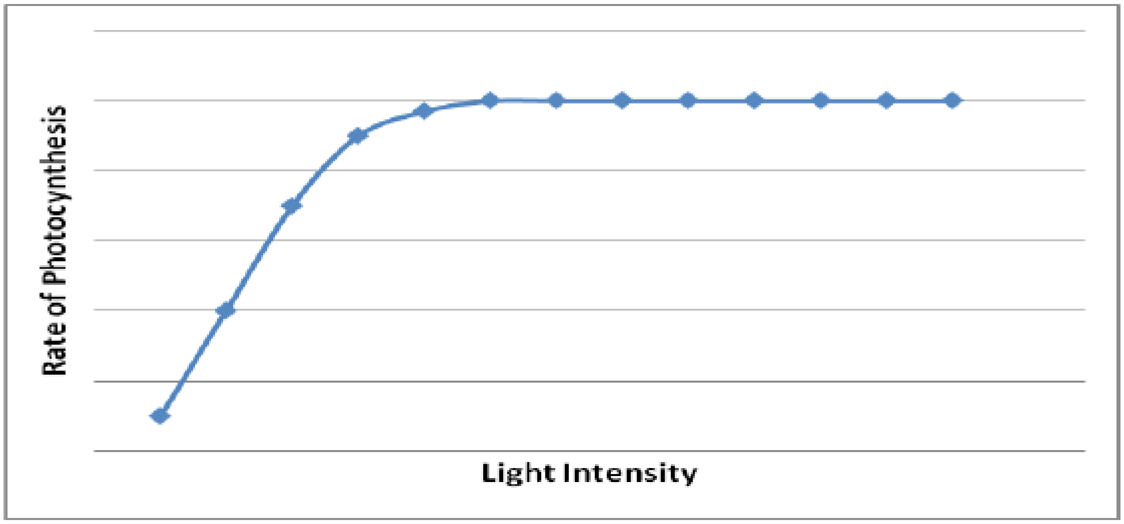
- ✓ Use the graphs to analyze and interpret data to determine a relationship between the dependent and independent variables.
- ✓ A **line graph** is used for continuous quantitative data.
- ✓ A **bar graph** is used for non-continuous data which is usually categorical.
- ✓ A **circle graph** shows a relationship among parts of a whole. Circle graphs often involve percentage data.

Recognize the implications of various graphs:

- ✓ Recognize the relationship between predator and prey by interpreting the graph. The population of foxes is inversely related to the rabbit's population.



- ✓ Interpret the relationship between the intensity of light and the rate of photosynthesis: The rate of photosynthesis is affected by light intensity up to about 250 watts/m^2; from that point on, light intensity has no effect on photosynthesis



B-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.

Key Concepts:

controlled scientific investigation
hypothesis

- ✓ In a controlled scientific investigation the ***hypothesis*** is a prediction about the relationship between an independent and dependent variable with all other variables being held constant.
- ✓ Results of a controlled investigation will either refute the hypothesis or verify it by supporting the hypothesis.
- ✓ After the hypothesis has been tested and data is gathered, the experimental data is reviewed using data tables, charts, or graphical analysis.
- ✓ If the data is consistent with the prediction in the hypothesis, the hypothesis is supported.
- ✓ If the data is not consistent with the prediction in the hypothesis, the hypothesis is refuted.
- ✓ The shape of a graph can show the relationship between the variables in the hypothesis (See graph shapes in B-1.5).
- ✓ If the data does support the relationship, the hypothesis is still always tentative and subject to further investigation. Scientists repeat investigations and do different investigations to test the same hypothesis because the hypothesis is always tentative, and another investigation could refute the relationship predicted.

- ✓ Scientific laws express principles in science that have been tested and tested and always shown to support the same hypothesis. Even these laws, however, can be shown to need revision as new scientific evidence is found with improved technology, advanced scientific knowledge, and more controlled scientific investigations based on these.

B-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

Key Concepts:
Technological design or product
Criteria: cost, time, materials

- ✓ Technological designs or products are produced by the application of scientific knowledge to meet specific needs of humans. The field of engineering focuses on these processes.

There are four stages of technological design:

- ✓ Problem identification
- ✓ Solution design (a process or a product)
- ✓ Implementation
- ✓ Evaluation

Common requirements within the solution design stage of all technological designs or products include:

- ✓ Cost effectiveness or lowest cost for production;
  - ✓ Time effectiveness or the least amount of time required for production, and
- ✓ Materials that meet specific criteria, such as:
  - ✓ Solves the problem
  - ✓ Reasonably priced
  - ✓ Availability
  - ✓ Durability
  - ✓ Not harmful to users or to the environment
  - ✓ Qualities matching requirements for product or solution
  - ✓ Manufacturing process matches characteristics of the material
- ✓ Benefits need to exceed the risk.
- ✓ There are tradeoffs among the various criteria. For example, the best material for a specific purpose may be too expensive.

B-1.8 Compare the processes of scientific investigation and technological design.

Key Concepts:
Science, Technology
Scientific investigation
Technological design

- ✓ ***Science*** is a process of inquiry that searches for relationships that explain and predict the physical, living and designed world.
- ✓ ***Technology*** is the application of scientific discoveries to meet human needs and goals through the development of products and processes.
- ✓ The processes of ***scientific investigation*** are followed to determine the relationship between an independent and dependent variable described by a hypothesis. The results of scientific investigations can advance science knowledge.
- ✓ The processes of ***technological design*** are followed to design products or processes to meet specified needs. The results of technological designs can advance standard of living in societies.
- ✓ In general, the field of engineering is responsible for technological designs or products by applying science to make products or design processes that meet specific needs of mankind.

The process of controlled scientific investigations:

- ✓ Asks questions about the natural world;
- ✓ Forms hypotheses to suggest a relationship between dependent and independent variables;
- ✓ Investigates the relationships between the dependent and independent variables;
- ✓ Analyzes the data from investigations and draws conclusions as to whether or not the hypothesis was supported.

The technological design process is used to design products and processes that people can use. The process may involve:

- ✓ A problem or need is identified
- ✓ A solution is designed to meet the need or solve the problem identified.
- ✓ The solution or product is developed and tested.
- ✓ The results of the implementation are analyzed to determine how well the solution or product successfully solved the problem or met the need.

Some ways that the two processes might be compared

Scientific Investigation	Technological Design
Identifies a problem – asks a question	Identifies a problem or need
Researches related information	Researches related information
Designs an investigation or experiment	Designs a process or a product
Conducts the investigation or experiment – repeated trials	Implements the design or the process – repeated testing
Analyzes the results	Analyzes the results

B-1.9 Use appropriate safety procedures when conducting investigations.

Key Concepts:
Safety procedures
Investigations

- ✓ **Personal safety** – follow only the designated lab procedures; be sure to understand the meaning of any safety symbols shown, wear proper clothing and shoes for the lab, use protective equipment (goggles, aprons,…), tie back loose hair, never eat or drink in lab room, use proper technique for touching or smelling materials, be careful when using sharps (any item that can puncture, cut, or scrape the skin.)
- ✓ **Work area safety** – use only designated chemicals or equipment, keep work area clear and uncluttered, do not point heated containers at yourself or anyone else, be sure all burners or hot plates are turned off when the lab is finished, know the location and use of the fire extinguisher, safety blanket, eyewash station, safety shower, and first aid kit, disconnect electrical devices, follow clean-up procedures as designated by the teacher.
- ✓ Safely and accurately practice appropriate techniques associated with the equipment and materials used in the activities conducted in the laboratory and classroom (see B-1.2 for materials lists).
- ✓ Abide by the safety rules in the course safety contract.
- ✓ Report any laboratory safety incidents (spills, accidents, or injuries) to the teacher.