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ABSTRACT

A nine-week prerequisite course for biology students is presented in this monograph. A course outline is presented to provide the student with some idea of the topics and activities that he will encounter. A suggested pretest is included in the monograph which covers 32 objectives. Three Learning Activity Packages are presented. Package A - Introduction to Biology - includes suggested films, readings, lectures and written assignments to develop the meaning of biology, the history and importance of biology, the branches of biology and scientific methods. Package B - Introduction to Instrumentation - presents laboratory equipment and its use with greatest emphasis on optical instruments. Learning Package C - Introduction to Metric Measurement - includes reading assignments, experiences in measurement, and quizzes on this particular concept, as well as on the use of the Bunsen Burner and the thermometer. Four enrichment activities and four remedial activities are suggested and developed. Each of the Learning Activity Packages has 10-12 behavioral objectives. These are itemized and presented for the student and constitute the basis for all pre- and post-test items. (Author/EB)

BIOLOGY 306:
MEASUREMENT AND INSTRUMENTATION

A nine-week prerequisite course for all biology students at Thomas McKean High School

By

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UNIT I, BIOLOGY 306
MEASUREMENT AND INSTRUMENTATION
COURSE OUTLINE

NAME ____________________

GROUP __________

Introduction - This course outline is for the purpose of providing you with a general picture of the general topics and activities that you will experience and be expected to become well acquainted with during this 9 weeks. Keep the outline in your biology notebook so that you may refer to it as you progress through the course. In this way you can keep track of an area that you may miss during an absence or that may be a weak spot where you need additional study.

Pretest I: (______________ date) (covers 32 objectives)

Learning Activity Package A - Introduction to Biology (12 objectives)

1. Meaning of biology

   Film:

2. History and importance of biology

   a. Reading assignment:

      #1. BSCS Yellow - Chapter 2 (think what you might answer to questions #2, 7-9, and 11 on page 43)
      or
      #2. BSCS Blue - Chapter 4 (how would you respond to questions #1, 3, 6-8 on page 78-79?)

   b. Lecture: "Abiogenesis vs. Biogenesis and Early Biologists" (Answer the review carefully) (______________ due date)

   c. Written assignment: "Famous Biologists" - A Crossword Puzzle (______________ due date) ☐

3. Branches of biology

   a. Reading assignment:

      #1. BSCS Yellow - pages 3-10
      and
      #2. Moon - pages 10-11

   b. Written assignment: "Branches of Biology" (______________ due date)

4. Scientific Methods

   a. Reading assignment:

      #1. BSCS Yellow - p. 14-17 (how would you respond to questions #3 and 10 on page 22?)
      and
      #2. Reading: "Science and Scientific Methods"

   b. Program: "How to Graph" (______________ due date)

   c. Lab demonstration: "Respiration Rate in Goldfish" (______________ due date)

d. Student progress report

5. Quiz I A: "Introduction to Biology" (covers 12 objectives) (__________) date

Learning Activity Package B - Introduction to Instrumentation (10 objectives)

1. Lab equipment and its use

   a. Lab Activity: "Lab Equipment: (__________) due date

   b. Quiz I B1: "Lab Equipment" (covers objective 2.1) (__________) due date

2. Optical instruments

   a. Study assignment: "Microscopy"

   b. Lab: "The Compound Microscope" (__________) due date

   c. Lab: "The Dissecting Microscope (__________) due date

   d. Film: "World of the Microscope" (__________) date

   e. Quiz I B2: "Optical Instruments" (__________) due date

   (covers 9 objectives)

Learning Activity Package C - Introduction to Metric Measurement (11 objectives)

1. The basics of metric measurement

   a. Reading assignment: "Measurement Systems"

   b. Practice sheets (__________) due date

2. Experiences in Measurement

   a. Length measurement: The Crayfish (__________) due date

   b. Quiz I C 1: "Measurement of Length" (__________) date

   c. Weight and Volume (__________) due date

   d. Quiz I C 2: "Measurement of Weight" (__________) date

   e. Quiz I C 3: "Measurement of Volume" (__________) date

   f. Use of The Bunsen Burner and The Thermometer (__________) due date

   g. Quiz I C 4: "The Thermometer" (__________) date

Post test I 1: (______________) (covers 33 objectives)
date

Enrichment Activity #1: "An Exercise in Micrometry"

Enrichment Activity #2: "Measurement Under The Microscope"

Enrichment Activity #3: "The Volumeter"

Enrichment Activity #4: "Electrolysis of Water"

Remedial Activity #1: "Investigation in Biogenesis"

Remedial Activity #2: "A Lab Equipment Key"

Remedial Activity #3: "Microscope Use"

Remedial Activity #4: "Metric Measurement"

Post test I 2: (____________) (covers 33 objectives)
date

UNIT I, BIOLOGY 306
MEASUREMENT AND INSTRUMENTATION
COURSE OUTLINE

NAME ________________

GROUP ________

Introduction - This course outline is for the purpose of providing you with a general picture of the general topics and activities that you will experience and be expected to become well acquainted with during this 9 weeks. Keep the outline in your biology notebook so that you may refer to it as you progress through the course. In this way you can keep track of an area that you may miss during an absence or that may be a weak spot where you need additional study.

Pretest I: (____________) (covers 32 objectives)
due date

Learning Activity Package A - Introduction to Biology (12 objectives)

1. Meaning of biology

   Film:

   a. Reading assignment: Frazier pages 11-14
      (How might you answer questions #5 and 6 on page 21?)

2. History and importance of biology

   a. Lecture: "Abiogenesis vs. Biogenesis and Early Biologists"
      (Answer the review carefully) (____________)
      due date

3. Branches of biology

   a. Reading assignment:

      #1. Frazier pages 14-15
      and
      #2. Moon pages 10-11

   b. Written assignment: "Branches of Biology" (____________)
      due date

4. Scientific Methods

   a. Reading assignment:

      #1. "Hypothesis Formation"
      and
      #2. Frazier pages 16-19
      and
      #3. Moon pages 2-5

      Written assignment: "Science Methods" (____________)
      due date

      #1. Frazier - copy statements #4-10 from page 20 on your answer sheet
      and
      #2. Moon - answer questions #4-6 from page 11 and 12 as fully as necessary

   b. Program: "How to Graph" (____________)
      due date

   c. Lab demonstration: "Respiration Rate in Goldfish" (__________)
      due date

   d. Student progress report.

5. Quiz I A: "Introduction to Biology" (________) date
(covers 12 objectives)

Learning Activity Package B - Introduction to Instrumentation (10 objectives)

1. Lab equipment and its use

(a) Lab Activity: "Lab Equipment" (________) due date

(b) Quiz I B 1: "Lab Equipment" (________) due date
(covers objective 2.1)

2. Optical instruments

a. Study assignment: "Microscopy and Program"

b. Lab: "The Compound Microscope" (________) due date

c. Lab: "The Dissecting Microscope" (________) due date

d. Film: "World of the Microscope" (________) date

e. Quiz I B 2: "Optical Instruments" (________) due date
(covers 9 objectives

Learning Activity Package C - Introduction to Metric Measurement (11 objectives)

1. The basics of metric measurement

a. Reading assignment: "Measurement Systems"

b. Practice sheets (________) due date

2. Experiences

a. "Measuring Length in the Metric System" (________) due date

b. Quiz I-C-1: "Measurement of Length" (________) date

c. "Measuring Weight in Metric Units" (________) due date

d. Quiz I-C-2: "Measurement of Weight" (________) date

e. "Measuring Volume in Metric Units" (________) due date

f. Quiz I-C-3: "Measurement of Volume" (________) date

g. Exercise: "Tools of the Scientist" (________) due date

h. Bunsen Burner and Thermometer (________) due date

i. Quiz I-C-4: "The Thermometer" (________) date

Post test I 1: (____________ date) (covers 33 objectives)

Enrichment Activity #1: "An Exercise in Micrometry"

Enrichment Activity #2: "Measurement Under The Microscope"

Enrichment Activity #3: "The Volumeter"

Enrichment Activity #4: "Electrolysis of Water"

Remedial Activity #1: "Investigation in Biogenesis"

Remedial Activity #2: "A Lab Equipment Key"

Remedial Activity #3: "Microscope Use"

Remedial Activity #4: "Metric Measurement"

Post test I 2: (____________ date) (covers 33 objectives)

UNIT I - BIOLOGY 306
MEASUREMENT AND INSTRUMENTATION
BEHAVIORAL OBJECTIVES

NAME ____________________

GROUP ________

Introduction - Each of the following objectives listed in this paper is a goal for the course. They tell you what you will be able to do or what new ideas you will have as you go through the course. You should refer to the objectives frequently to find out what you are expected to know so you will know what you should study.

Each of the 33 objectives in this list has its own number and every question on your tests will ask you about a certain numbered objective. The tests and quizzes have been made up to see if you know the ideas in each objective. If you get the right answer on the test, then you know the objective - you have achieved a goal.

The first test you will be given is called Pretest I since it is the pretest for Unit I. It has one test question for each of the 33 objectives and will be given to you before you have begun the course. You may not be able to get many answers right on this test. But don't worry about that. You will discover which objectives you already know and which ones you don't know yet. Your instructor will be able to decide how to help you achieve the goals.

Since Pretest I asks you about ideas you haven't learned yet, you can see how much better you do on them as the course progresses. Remember, getting only a few answers right does not mean getting a bad final grade. The Pretest and later the Posttests are designed to tell you which objectives you have learned and which ones you still need to study. If you get a better score each time, you are doing very well.

The number you get right on each test is called your score and we would like for you to get a better score each time. Later, you will be asked to keep a graph of your scores in your notebook as a means of making a personal progress report to yourself. You should not compare your scores with anyone else in the class. Beating someone else should not be important to you. What should be important is to beat your own score every time. To do this, try to learn each objective as soon as it is presented to you and refer to the list of objectives frequently for review.

Learning Activity Package A: Introduction to Biology (12 objectives)

1.1 The student will be able to identify early biologists with their contributions to biology.

1.2 The student will be able to distinguish between the various fields of biology.

1.3 Given a list of scientific method descriptions, the student will be able to select the best description.

1.4 Given a paragraph, the student should be able to distinguish between facts and testable hypotheses.

1.5 Given a set of statements, the student will be ably to formulate a hypothesis.

1.6 The student will be able to state in logical order the basic activities of science.

1.7 Given numerical data, the student will be able to construct a graph.

1.8 Given a list of dependent and independent variables, the student will identify the statements as dependent or independent.

1.9 The student will be able to interpret graphs by selecting information shown in the graph necessary to solve a given problem.

1.10 The student will be able to interpret charts by making predictions based on the data presented in the charts.

1.11 The student will be able to distinguish between direct and inverse variations by identifying the variation shown on a graph.

1.12 The student will demonstrate competency in the calculation of percents and/or averages from given data.

Learning Activity Package B: Introduction to Instrumentation (10 objectives)

2.1 The student will be able to identify laboratory equipment by their structural-functional relationship.

2.2 Given a diagram of the compound microscope, the student will be able to identify the parts.

2.3 Given a diagram of the dissecting microscope, the student will be able to identify the parts.

2.4 Given necessary materials, the student will be able to prepare a wet mount for use with the microscope.

2.5 The student will show competency in the ability to focus the compound microscope on a wet mount using low and high power objectives.

2.6 The student will show competency in the ability to focus a dissecting microscope on a specimen using low and high power objectives and/or various light combinations.

2.7 Given an appropriate specimen the student will demonstrate skill in drawing and labeling a specimen.

2.8 The student will be able to demonstrate proper techniques of safe handling and caring for optical instruments.

2.9 The student will be able to observe and record the properties of the image produced by a compound microscope.

2.10 The student will be able to observe and record the properties of the image produced by a dissecting microscope.

Learning Activity Package C: Introduction to Measurement
(11 objectives)

3.1 Using the metric system, the student will be able to measure a given figure with accuracy.

3.2 The student will identify from a list of different metric units those that are equal in value.

3.3 The student will be able to match metric prefixes to corresponding numerical values.

3.4 Given a sample, the student will be able to weigh accurately using metric system units.

3.5 Using the metric system, the student will be able to find correct volume of a sample.

3.6 Given a list of miscellaneous metric units, the student should be able to select three basic units.

3.7 The student will be able to demonstrate knowledge of thermal measurement by choosing the correct temperature from a list of temperatures.

3.8 The student will be able to make conversions between English and metric values.

3.9 The student will be able to distinguish between definite and indefinite measures.

3.10 Given the necessary equipment, the student will exhibit his concept of a microscopic unit of measure by correctly estimating the size of a given specimen under the compound microscope.

3.11 Given the necessary equipment, the student will exhibit his concept of a magnified object by correctly estimating the size of a given specimen under the dissecting microscope.

BIOLOGY 306 - PRETEST
MEASUREMENT & INSTRUMENTATION

(1.1) The man whom we credit with the discovery of the compound microscope is:
A. Harvey B. Redi C. Needham D. Van Leeuwenhoek

(1.2) The science of classification is
A. Taxonomy B. Genetics C. Botany D. Bacteriology

(1.3) Which of the following statements best describes the scientific method?
A. Accumulate observations and ideas, form a hypothesis, test the hypothesis by experiment, and then build a theory after positive test results.
B. Form an opinion about an idea and assume it to be theory.
C. Assume all data to be facts and eliminate the necessity to experiment.
D. Study the idea of interest to see if it has any validity to it.

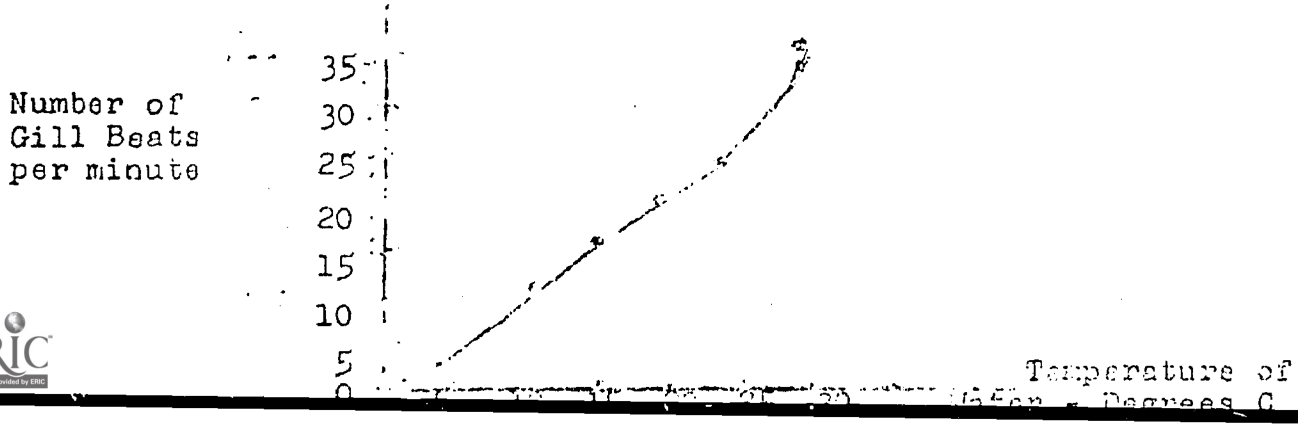
(1.4) Redi's suggestion that maggots did not arise spontaneously in rotting meat, but that they came from eggs deposited there by adult flies is
A. Fact B. Hypothesis C. Experiment D. Data

(1.5) Redi placed meat in jars, some of which were sealed and some of which were left open. He then observed these jars to see if maggots appeared in them. His recorded observations would constitute
A. A hypothesis B. An assumption C. Data D. An experiment

(1.6) A scientist seeks background knowledge in the investigation of a problem because
A. He learns to understand the problem.
B. He enjoys reading.
C. He knows that scientists should read as much as possible.
D. He needs more facts to help him prepare a controlled experiment.

Objectives (1.7) through (1.11) are based on the information and graph below:
A student recently performed an experiment on respiration rate. The experiment was conducted using 1000 ml. beakers and goldfish. Changes in water temperature were made to find out if water temperature has any affect on the respiration rate of the fish. The results were recorded on the graph below.

GOLDFISH RESPIRATION RATE.



(1.7) In the graph on page 1, the number of gill beats
A. is on the Y-axis
B. shows an inverse variation
C. is on the X-axis.
D. is on the horizontal axis.

(1.8) From the information given in the graph and reading, the respiration rate seems to be dependent upon
A. the size of the beaker.
B. the amount of water present.
C. the amount of food present.
D. the water temperature.

(1.9) The best interpretation of the graph is
A. small goldfish are able to survive a greater temperature variation than large ones.
B. water temperature directly influences goldfish respiration rate.
C. the amount of oxygen is dependent on the size of the container.
D. the larger the fish, the lower the respiration rate regardless of temperature variation.

(1.10) After making careful observations of the graph an experimenter could predict that
A. decreasing water temperature will increase respiration rate.
B. at $0^{o}C$, respiration rate should be 40 beats per minute.
C. increasing the water temperature will increase respiration rate.
D. increasing water temperature will decrease respiration rate.

(1.11) Which one of the following presents a direct variation?
A. Lower water temperature results in a lower respiration rate.
B. High water temperature results in low repiration rate.
C. At 15^{o} C, the respiration rate was found to be 40 beats per minute.
D. Lower water temperature results in higher respiration rate.

(1.12) On a 50 point biology test, Dr. Doolittle has a raw score of 40 (40 correct answers). What is his percentage of correct answers on the test?
A. 30% B. 50% C. 80% D. 85%

(2.1) Which one of the following pieces of lab equipment would most likely be used to measure 1 ml. of water.
A. 500 ml. beaker
B. 50 ml. graduated cylinder
C. 10 ml. Erlenmeyer flask
D. serological pipette

(2.2) Upon careful observation of the compound microscope, it was found to have a revolving disc that regulates the amount of lifht. This is known as a
A. light filter B. diaphragm C. mirror D. objective.

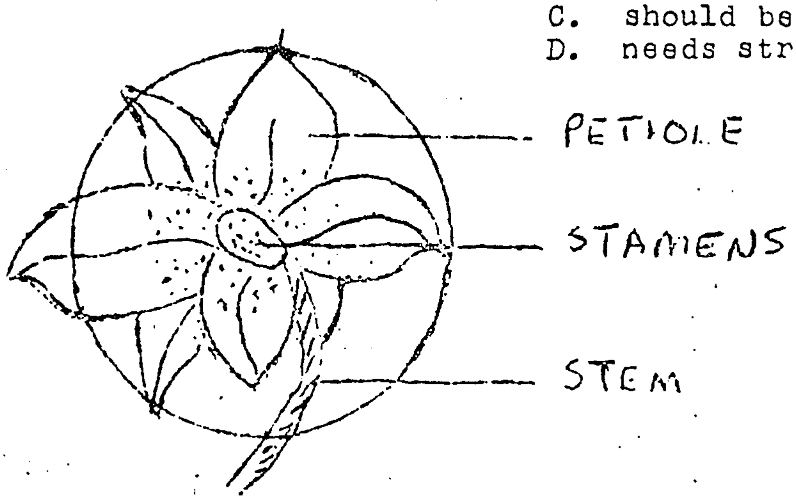
2.3) The dissecting microscope has all of the following parts except
A. a mirror. B. a built in light source.
C. two eyepieces (oculars). D. a body tube.

(2.4) In preparing a wet mount for microscope study, the student would do all of the following except:
A. center the specimen on the slide.
B. add a drop of water to the specimen.
C. lightly place a cover slip over the specimen.
D. press the cover slip tightly on the specimen with the thumb.

(2.5) When focusing a compound microscope on an object of study, the student should first:
A. adjust the mirror for the amount of light needed.
B. focus the object under high power and then adjust the mirror.
C. bring the object into view using the fine adjustment.
D. bring the high objective lens to the object and focus on the object using the course adjustment.

(2.6) When focusing a dissecting microscope on an object of study, the student should first:
A. rotate the body tube to high power.
B. adjust the microscope so that it gives the lowest possible magnification.
C. place one eye on an ocular and slowly raise the body tube by rotating the focus knob.
D. adjust oculars until the distance between their centers matches the distance between the centers of your eyes.

(2.7) The drawing of the flower:
A. should be centered better.
B. should have better lettering.
C. should be of an appropriate size.
D. needs straight guidelines.



(2.8) Of the following rules for safe handling and care of optical instruments, the one which is least correct is:
A. rest one eye by keeping it closed at all times.
B. begin with the low power objective down at the slide and focus by bringing the objective up with coarse adjustment.
C. use both hands, when transporting microscope - one hand on the arm and one hand under the base.
D. never change from the low power objective to the high power objective unless the specimen is in focus first under the low power objective.

(2.9) Of the following descriptions, which one best describes the image produced by a compound microscope?
A. the image appears normal size.
B. the image appears inverted only.
C. the image appears inverted and backward.
D. the image appears inverted, backward, and magnified.

(2.10) Of the following descriptions which one best describes the image produced by a dissecting microscope?
A. the image appears normal size.
B. the image appears inverted only.
C. the image appears inverted and backward.
D. the image appears magnified.

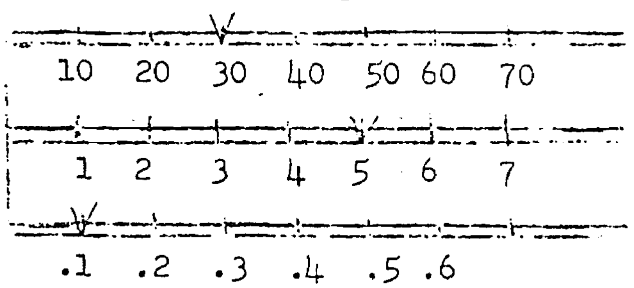
(3.1) Using the metric ruler provided, the most accurate measurement of the line below is:

A. 750 mm B. 7 cm C. 8 cm D. .5 m

(3.2) Of the following metric equalities, which one is incorrect?
A. 40 cm = 4000 mm B. 30 ℓ = 300 dℓ
C. 100 kg = 100,000 g D. 20 mm = 2 cm

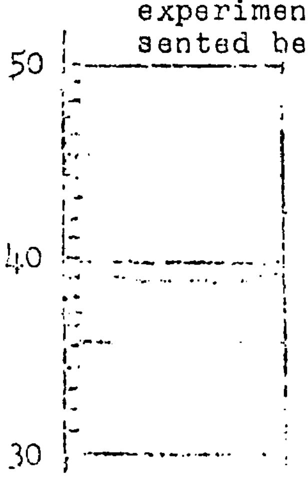
(3.3) The metric prefix <u>milli</u> corresponds to the numerical value
A. 1000 B. $\frac{1}{100}$ C. $\frac{1}{1000}$ D. 0.1

(3.4) The most correct reading indicated on the balance beam below is:



A. 30.51 grams B. 35.01 grams C. 35.1 grams D. 305.1 grams

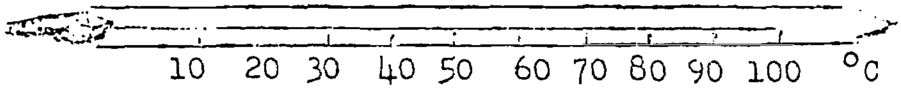
(3.5) A student was asked to measure 35 milliliters of water for an experiment in the lab. He took the graduated cylinder (represented below) to the teacher and the teacher said most correctly:



A. "Add 1 more ml. of water to meet the required 35 ml."
B. "Pour out 4 ml. of water. You have too much."
C. "Pour out 5 ml. of water. You don't need that much."
D. "Add 4 ml. of water or your specimen will be dry.

(3.6) Which of the following is a basic unit in the metric system?
A. milligram C. liter
B. centimeter D. kilogram

(3.7) On the thermometer represented below, the reading is nearest

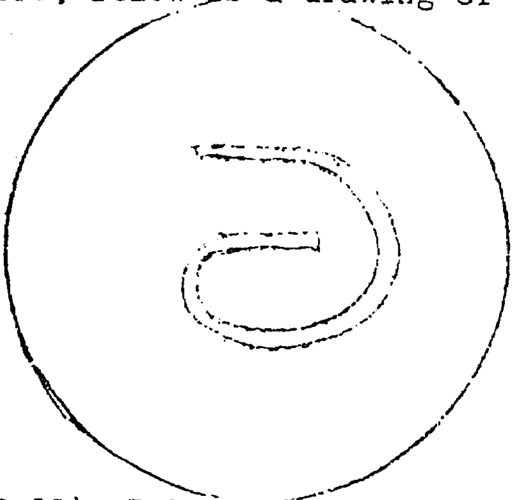


A. 100° C B. 100° F C. 0°C D. 90°F

(3.8) Of the following English-metric conversions which is least correct?
A. 2.54 cm = 1 in. B. 25.4 cm = 1 in. C. 1 in. = .254 dm
D. 25.4 mm = 1 in.

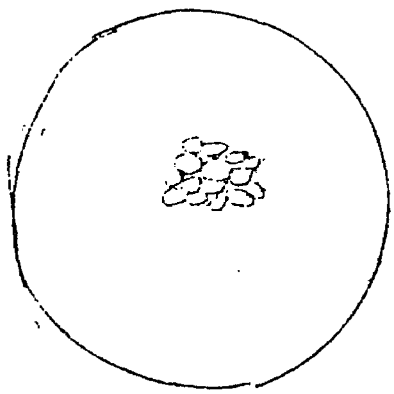
(3.9) Of the following phrases concerning measurement, the one which is an indefinite amount is
A. 12 lbs. of sugar C. a bunch of bananas
B. 2 liters of gasoline D. one dozen eggs

(3.10) Below is a drawing of the letter "e" as it appears under the compound microscope when magnified 100 times. If the diameter of the low power field is 1.5 mm, what is the width of the letter?



A. About 15 μ
B. About 150 μ
C. About 1000 μ
D. About 500 μ

(3.11) Below is a cluster of bacteria spores which were drawn as they appeared under a dissecting microscope. If the diameter of the field is 8 cm and the spores are magnified 3 X; what is the approximate diameter of this cluster of spores?



A. 8 cm.
B. 2 cm.
C. 4 cm.
D. 6 cm.

LECTURE - NAME______________________

LIFE FROM NON-LIFE - LIFE FROM LIFE GROUP________

Background

Life coming from life is a commonly accepted belief today. During the middle ages, a disagreement started as to how life really originates. Some scientists believed that dead materials could give rise to living organisms. Other scientists argued that this was not the case but rather that only living organisms could produce new live organisms. This conflict took nearly 300 years to settle.

Purpose

In this lesson we will be concerned with this classic biological argument as well as some of the men who were to be involved in its continuance. Special emphasis will be placed on the experimental methods employed by the various scientists involved.

Procedure

As you follow the presentation of this lesson use the worksheet provided you for the taking of notes. When you finish recording your notes use them to help you answer all questions.

Notes

1. List three ideas that accounted for the origin of organisms.
    a.
    b.
    c.
2. Aristotle's viewpoint -
3. MiddlesAges ideas -
4. van Helmont's "recipe" -
5. Spontaneous generation theory -
6. Redi's experiment -

7. Microorganisms and spontaneous generation
   a. Leeuwenhoek -

   b. Needham -

   c. Spallanzoni's experiment -

8. Renewal of controversy
   a. Pouchet -

   b. Pasteur -

Questions

____1. Aristotle's idea that fish arose from mud is an example of (a) life from life, (b) life from unlike life, (c) life from non-life, (d) superstition.

____2. Which of the following scientists did not believe in spontaneous generation?
(a) Spallanzani (b) Needham (c) van Helmont (d) Aristotle.

____3. An example of new life from unlike life would be
(a) dog from dog (b) frog from mud (c) colt from mare
(d) lamb from tree.

____4. What most important factor was overlooked by van Helmont in his mouse "recipe"? (a) control (b) observation (c) research
(d) food.

____5. Of the following which was the experimental variable in Redi's work? (a) dead animals (b) maggots (c) open container
(d) gauze covering.

____6. How did Spallanzani produce different results from those of Needham? (a) By boiling his cultures (b) By using airtight seals
(c) By making the experiment work out the way he wanted it to
(d) None of these.

____7. Why did Pasteur's flask produce no microorganisms after sterilization?
(a) No air was admitted (b) Because he boiled the contents
(c) The flask was sealed (d) Spores were trapped in the S curve of the flask.

LECTURE - NAME ____________________

ABIOGENESIS VS. BIOGENESIS GROUP ________

Background

Life coming from life is a notion generally accepted today. However, this was not always a common belief among scientists. For nearly 300 years this controversy was argued by opposing scientific factions. Scientific methods played an instrumental role in resolving this argument.

Purpose

This lesson will be primarily concerned with the men and the sequency of events involved in this classic biological struggle. Particular note will be made of the experimental methods used.

Procedure

Follow along with the presentation by recording notes concerning people, their methods, and contributions. Answer all questions that relate to the lecture.

Notes

1. Origin of organisms

   a.

   b.

   c.

2. "Barnacle goose theory" -

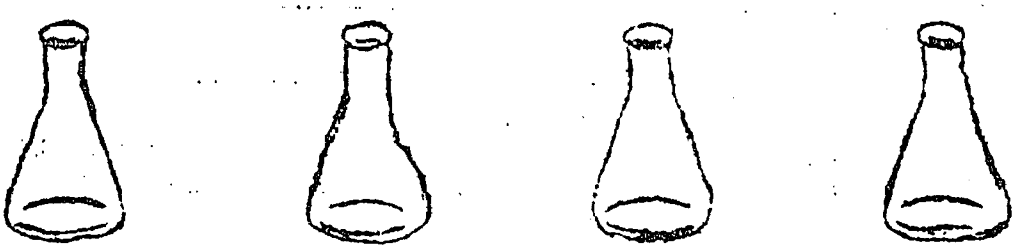
3. Spontaneous generation -

4. Aristotle and van Helmont - "Mud puppies and Mice"

5. Redi's experimental method - "Maggots and Meat"

6. van Leewenhoek and microorganisms

7. Joblot and hay infusions (notes on back)



A. Sterilized and open B. Sterilized and waxed C. Sterilized and corked D. Sterilized and waxed - S-tube

8. Needham needles the biogenesists

9. Spallanzani's repeat performance

10. After effects of Spallanzani's work upon the controversy.

11. Pouchet's artificial infusions

12. Pasteur answers Pouchet

13. Conclusions

ABIOGENESIS VS. BIOGENESIS

Grade______

NAME______________________

QUESTIONS FOR REVIEW

GROUP__________

____1. A frog developing from the mud of a pond is an example of (a) abiogenesis, (b) biogenesis, (c) asexual reproduction (d) sexual reproduction.

____2. Another name for abiogenesis is (a) embryology, (b) spontaneous combustion, (c) spontaneous generation, (d) re-incarnation.

____3. All but one of the following advocated abiogenesis. Which scientist did not?
(a) Needham (b) Aristotle (c) van Helmont (d) Spallanzani.

____4. Redi differed from van Helmont in his experimental work because of his (a) scientific interest, (b) use of a control, (c) use of observation, (d) nationality.

____5. In Joblot's experiment the variable was the (a) open vessel, (b) hay infusion, (c) boiling time, (d) parchment.

____6. After the development of the microscope, microorganisms became the subject of debate. Biogenesists and abiogenesists agreed on which of the following points?
(a) boiling killed microorganisms in hay infusions
(b) protozoans were generated from the hay and water
(c) air was a contaminating factor
(d) inactive spores became active in a hay infusion.

____7. Pasteur and Pouchet performed basically similar experiments but reached conflicting conclusions. Which one of the following reasons <u>most</u> likely caused differing results?
(a) improper boiling of the cultures, (b) the exclusion of air, (c) different types of cultures, (d) close-mindedness.

The following questions are taken from the accompanying diagram. Check the pictures closely and read the associated captions. Answer in terms of the abiogenesis-biogenesis controversy.

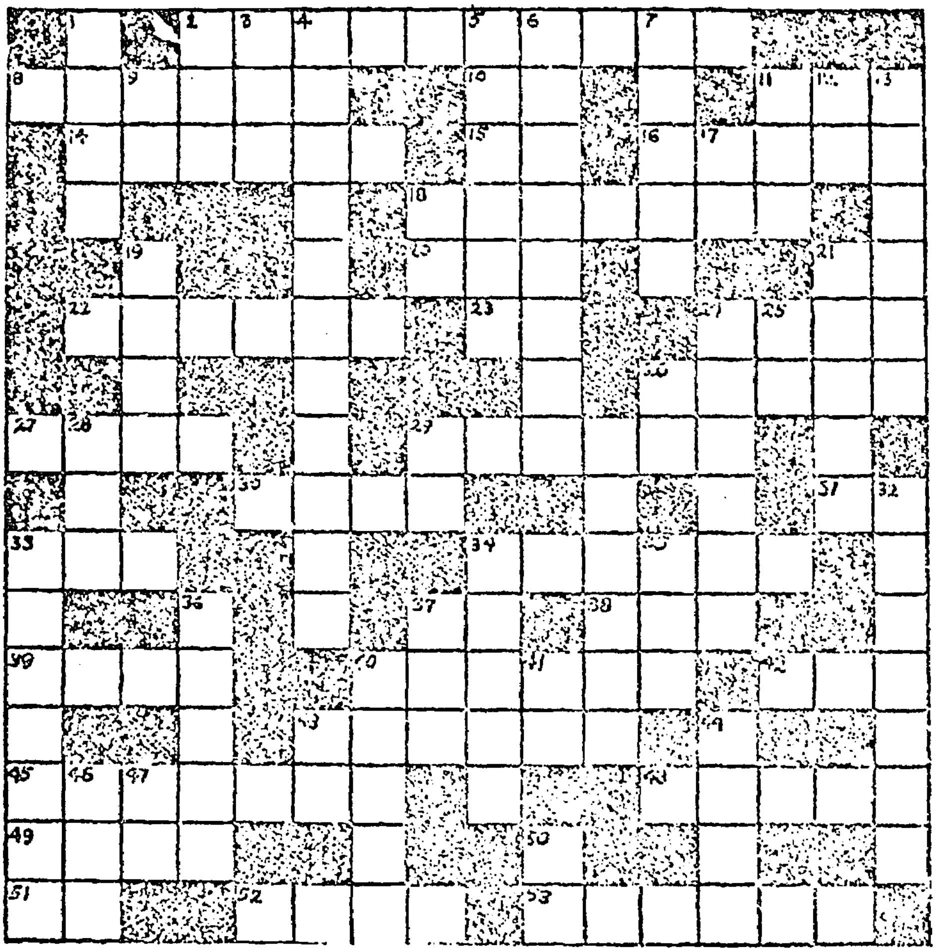
____8. What will most likely occur to beaker A?
(a) solution will evaporate, (b) no organisms will develop, (c) organisms will cause it to turn cloudy, (d) solution will transform into a goose.

____9. Which two flasks would be most like the experimental set-up of Spallanzani? (a) A and C, (b) B and C, (c) B and D, (d) A and D.

____10. Of the four flasks which best takes into account conditions favorable to both the abiogenesists and the biogenesists?
(a) sterile and waxed, (b) sterile and open, (c) sterile and corked, (d) sterile, waxed and S tube.

GROUP ____________________

27. MEN OF SCIENCE



Across

2. Dr. Joseph ______________ discovered the remedy for pellagra.
8. Castle.
10. Commit an act.
11. Supporter, as of a team.
14. Dr. Joseph ____________ was the first to use antiseptics in surgery.
15. Plural pronoun.
16. Operate a vehicle.
18. Sir Frederick _____________ discovered insulin.
20. Professional skill.
21. Abbreviation for the state where Coolidge was born.
22. Gregor ________ formed laws of heredity after intensive study of garden peas.
23. Doubly Good (abbr.).
24. Pasteur was a great health _______________.
26. Dr. ___________ developed oral polio vaccine.
27. The theory of spontaneous generation was disproved by _______________.
29. The smallpox vaccine was developed by Dr. _____________.

Robert ________ discovered various bacilli and made vaccines to combat the diseases.

27. Men of Science

Across

33. Diseases characterized by eruptions are known as ______________.
34. Alexis ______ is noted for study of living cells and tissues and cancer wor
37. First two letters of 34 Down.
38. Spring month.
39. Individual performance.
40. Dr. Thomas ______________ was awarded the Nobel Prize in 1933 for the discovery of hereditary functions of chromosomes.
42. Short version of first name of scientist who invented the incandescent lam
43. Designating any generation successive to the parent.
45. Christian ______________ discovered the cause of polyneuritis.
48. First name of 4 Down.
49. Encourage.
51. First two letters of 19 Down.
52. James ______ was a Scottish scientist whose name has become a common electrical term.
53. First name of 30 Across.

Down

1. Dr. Jonas ________ discovered polio vaccine.
2. Ether was originally called "laughing _____".
3. The month in which Halloween occurs (abbr.).
4. Van ________________ constructed the first microscope and gave the first clear description of the circulation of the blood.
5. First name of 29 Across.
6. X-rays were discovered by ________________.
7. Nickname given to people whose name is like 5 Down.
9. First two letters of 14 Across.
11. A pulpy Asian fruit.
12. Average (abbr.).
13. Isaac __________ is credited with discovering the law of gravity.
17. Registered Nurse (abbr.).
18. Bachelor of Arts (abbr.).
19. Dr. Walter _______ proved that yellow fever was transmitted by the bite of the Aedes mosquito.
21. Hugo _____________ is noted for development of mutations.
24. William __________ was the first to show circulation of the blood.
25. Eager Beaver (abbr.).
26. Serious Epidemic (abbr.).
28. Self.
29. Just Healthy (abbr.).
32. Sir Alexander _______________ discovered penicillin.
33. Louis __________, often called the "father of bacteriology", is remembered for rabies vaccine.
34. Marie ________ and her husband discovered radium.
35. Sped.
36. ________ was the first to explain cell construction.
37. Colonel (abbr.).
40. Cure for pernicious anemia was discovered by _____________.
41. Abbreviation for state where Hot Springs Foundation is located.
43. Field Artillery (abbr.).
44. One time only.
46. Wrath.
47. Initials of 2 Across.
50. Mister (abbr.).

BRANCHES OF BIOLOGY

Name________________

Group________

Directions; Using the reading references given, describe each of the following specialized branches of biology.

1. Anatomy -

2. Bacteriology -

3. Botany -

4. Cytology -

5. Ecology -

6. Embryology -

7. Entomology -

8. Genetics -

9. Herpetology -

10. Morphology -

11. Pathology -

12. Physiology -

13. Taxonomy -

14. Zoology -

HYPOTHESIS FORMATION NAME____________________

GROUP__________

A. Forming a hypothesis is a technique of the scientific method that helps us make an educated guess about ideas or relationships. The hypothesis must be tested, and this is done by the collection through observation of more data that relate to the hypothesis. Once the hypothesis has been tested and proven as truth this information can be thought of as fact rather than assumption. In forming a hypothesis, we are asking for might-be's. Such "might-be's" are extremely useful parts of educated guesses for the scientist. They help him see what data to look for. For example, we could say that the respiration rate of goldfish might be influenced by water temperature, by the amount of oxygen, or by goldfish size. What made us think that these three things were important - experiment or experience?

B. We've stated three things that might influence the respiration rate. Which of these is most important? If you think that the most important influence on respiration rate is temperature, what kind of data would you look for? If you think that the amount of oxygen is the most important influence, what data would you look for?

C. Guiding "might-be's" have a definite name. They are called hypotheses. We can define a hypothesis as a "might-be", a possibility that we intend to test. Often these possibilities occur to us because of previous evidence or experience.

Let's look again at the questions we just asked. If you think water temperature is the most important influence on respiration rate, then what data would you look for?

D. Notice how all the statements on the board are similar. Each begins with an "If" and has a "then" in the middle? What follows the "If" in each statement?

E. What follows the "then" in each statement?

F. Are the consequences, or results, the same in each statement?

G. We have seen that it is useful for hypotheses to be stated in the form of "If..., then..." sentences. The if portion states the factor we think is an influence, the then portion states the consequences, or results we expect if the factor is an influence. In addition, the then portion tells us what data to look for in order to test that factor. We could picture it this way:

IF ____(factor), THEN____(result)____ ------→ DATA

Here are some examples of sentences that state hypotheses: (Underline the factor, underline the result. What data would you look for?)

1. If the water temperature influences the respiration rate of goldfish, then decreasing the water temperature should decrease goldfish respiration rate.

2. If the amount of oxygen influences the respiration rate of goldfish, then an increase in oxygen should increase goldfish respiration rate.

3. If the body size of goldfish influences the respiration rate, then a larger goldfish should have a higher respiration rate.

READING: SCIENCE AND SCIENTIFIC METHODS NAME________________

GROUP__________

Man is a biological organism. His primary activities are biological because without food he could not live and without reproduction human life would cease to exist. Man competes with other biological organisms for his food and frequently for his life. He struggles for his existence just as other organisms do, but he has one advantage not enjoyed by his competitors. This advantage is his ability to learn to a greater extent than any other organism and to profit by that learning.

Man can learn how his body functions and how his life is dependent on matter and energy derived from the earth, from the sun, and from other living organisms. He can learn the nature of the universal inter-relationships and interdependencies of living and nonliving things and so better control them for his benefit. He can learn the nature and habits of his competitors and he also must learn that to match successfully the strength of his competitors he must work with other members of his group. The battle against disease, insects, and erosion is no task for a single individual. Rather it is a task requiring the united effort of all the people.

Biological science is designed to give the student an understanding of basic biological principles so that he may better understand his own nature and that of all living things. With this understanding he can live more effectively as an individual and as a member of a group.

A science is a body of knowledge that is obtained by means of scientific methods concerning any part of the universe.

In using scientific methods, one makes observations concerning natural phenomena. The results of these observations (data) are recorded, classified, and analyzed, and from this information relationships are determined.

The observations to be useful must be made with great accuracy. To increase accuracy, various measuring devices are employed and the senses are extended by means of microscopes, telescopes, X-ray machines, and many other instruments.

Results of the observations (data) are classified in an orderly manner. The order is developed in accordance with what man thinks is logical and meaningful. Facts that appear related are grouped together.

The classified data are thought over in the search for relationships. It is here that the ability to think logically and brilliantly is of paramount importance. The great scientists of the past were great because they could see relationships not apparent to most men. Our modern "greats" qualify in the same manner.

Formulation of an hypothesis is a technique of the scientific method that aids in the search for relationships or generalizations. A hypothesis is a statement of relationships that goes beyond known facts. It is made proved and is no more than a reasonable guess concerning a possible relationship that seems to exist. This relationship is often between a factor which is thought to be a major influence on a situation and the results we would expect if that factor is, or is not, the major influence. The hypothesis may be stated in the form of an "if...., then...." sentence - the "if" portion stating the factor we think influences the situation, the "then" portion states the results we expect if the factor is an influence. The "then" portion tells us what data to look for in order to test that factor. For instance, if practice is a factor which might influence a person's ability to play tennis, then an increase in practice should result in an increased performance on the tennis court.

Now the hypothesis must be tested, and this is done by the collection through observation of more data that relate to the hypothesis. This testing may include experimentation, which is a controlled observation. In experimentation the emphasis is on the relationship between cause and effect. Two similar events are observed, both of which are exactly alike except for one factor. If the observed results of the events differ, the difference must have been due to the variable factor.

An hypothesis that has been tested may still stand as the best statement of the relationship available or it may be found to be totally incorrect, in which case it is discarded. A revaluation of all of the facts, including those brought out in the testing, is made and a new hypothesis is stated. As a third alternative the original hypothesis may be partly correct and in need only of modification.

A theory is an hypothesis that has withstood repeated tests, but which has not been tested sufficiently to be accepted as true with a very high degree of probability.

A principle is a relationship or generalization that is supported by such a wealth of data that its truth is very highly probable. It must be emphasized that no scientific fact, hypothesis, theory, or principle is ever proved absolutely true. Scientific truth is a matter of probability. The hypothesis, being based on a few facts only, has the least chance of being a true statement of relationships. Further observation may easily show that the hypothesis is untenable. The theory has a greater chance or probability of being a true statement of an actual relationship because it is supported by more observations. The principle (law or doctrine) has the greatest chance of surviving as a statement of relationships among natural phenomena because it is the result of the accumulation of years of repeated observations or facts that support the principle, the possibility that any facts will ever be discovered that disprove it is remote. However, the possibility always remains that such facts may someday be discovered. It should be remembered also that the relationships are man-made and are what seem to be logical explanations of the observed phenomena of nature.

Scientific methods may also be used in everyday life. Every individual holds certain things to be true or false, good or evil. These are opinions and on the basis of them all people make decisions that govern the course of their actions. Every individual must make many decisions during the course of his life, and the welfare of the individual, his family, and society as a whole depends on how well these decisions are made.

Scientific methods are useful in arriving at opinions that guide the course of action. In terms of scientific methods the opinion is the hypothesis, and a person trained in this method will be aware of the basis (facts) on which the opinion (hypothesis) has been made. His degree of confidence in the opinion will vary according to the adequacy of the facts used in its formulation. An opinion based on many verified facts will be given more weight than one without much substantiation. When an opinion has been accepted it will not be accepted unconditionally, but further information will be sought in order to re-evaluate it. In terms of the scientific method the hypothesis (opinion) will be tested. If this further information supports the original opinion, more confidence can be placed in it. However, if it disagrees with the opinion, all of the information must be re-examined in order to formulate a new one. A new hypothesis is made to fit all of the facts.

A person using scientific methods is open-minded. He has the ability to view his opinions in the light of facts and is willing to change his opinions in the light of new information. Such a person also reserves judgement if after considering the facts he realizes that they are not sufficient for the formulation of an opinion.

Many people are faced with the necessity of making a decision without adequate information to do it scientifically. They may lack both time and facilities for gathering the needed information; but the decision must be made nevertheless. In such cases the scientifically trained person seeks the advice of some one whose opinions are based on adequate information. The ability to recognize a competent authority and the willingness to be guided by his opinions are very important factors in living more scientifically.

HOW TO MAKE AND READ A GRAPH

Any scientist, when he is conducting an experiment, observes what is happening and makes a record of this information. This recorded information is what we call data. When the experiment is completed the scientist attempts to analyze or interpret this information, or data, in the hope that it will give him a better understanding of the events he is investigating.

A more commonly used technique in biology for comparing two or more sets of numerical data is a graph. This exercise is designed to help you make and read one type of graph, the line graph.

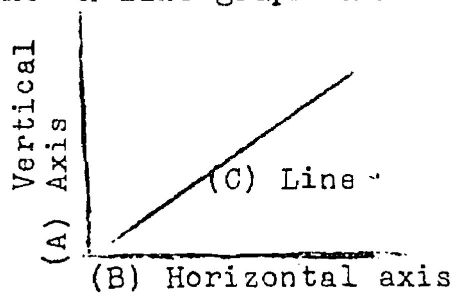
The data used to explain the construction of a line graph were gathered by counting the rate of gill cover movement, or beat, in a goldfish at different temperatures. By means of a line graph, the relation between gill cover beat and temperature can be illustrated.

1. The drawing below shows a line graph. A line graph has 3 basic parts. They are

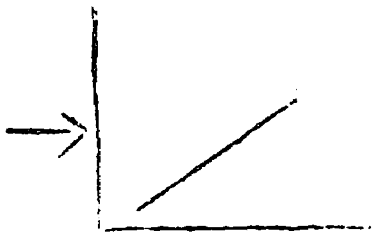
A. ____________ ____________,

B. ____________ ____________

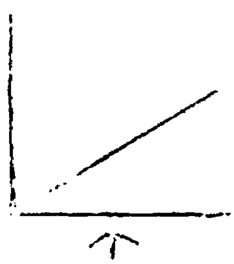
C. ________



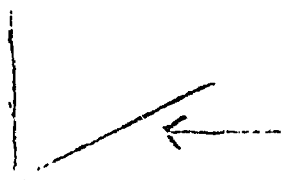
2. The arrow in this drawing points to the ____________ axis.



3. In this drawing the arrow points to the ____________ ____________.

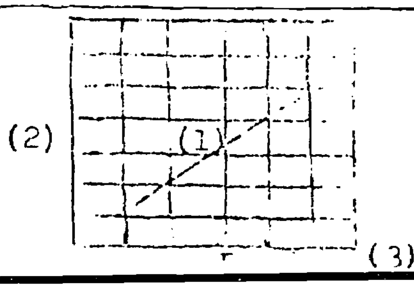


4. The arrow in this drawing points to the ____________.



5. Label the parts of a line graph.
1. ____________
2. ____________
3. ____________

____



6. The two sets of numbers to be compared by means of a line graph were collected in an experiment with goldfish by counting the number of gill cover beats per 15 seconds in a goldfish. A count was made when the temperature was 10°C (read: ten degrees centigrade).

Another count was made at 15° C; another at twenty degrees centigrade (20°C); and another at 25°C. The results are shown in the following table:

Temperature	10°C	15°C	20°D	25°C
Gill cover beats	5	14	24	32

The range of temperature was from _____ °C to _____ °C.

---

7. Examine the table. The range of gill cover beats was from (number) __________ to (number) __________.

---

8. At 10°C the gill cover beat was (number) _______, while at 20°C the gill cover beat was (number) ________.

---

9. As the temperature was increased, the gill cover beat: (a) decreased (b) remained the same (c) increased (choose one)

---

10. We have plotted in Fig. 1 the temperature and the average gill cover beats on a line graph to show you how a line graph is constructed and how to read a line graph.

The gill cover beat was recorded on which axis of the graph?

__________.

---

11. The temperatures used in the experiment were recorded on the __________ __________ of the graph.

---

12. The range of gill cover beats recorded was from 5 to 32. The possible range of gill cover beats is shown on the vertical axis be a series of numbers from 0 to (number) __________ .

---

13. The space between each number listed on the vertical axis is (equal/unequal) __________ . (choose one).

---

14. How many gill cover beats are represented by the space between each of the numbers on the vertical axis, that is, between 5 and 10, between 10 and 15, between 15 and 20, etc. (number) __________.

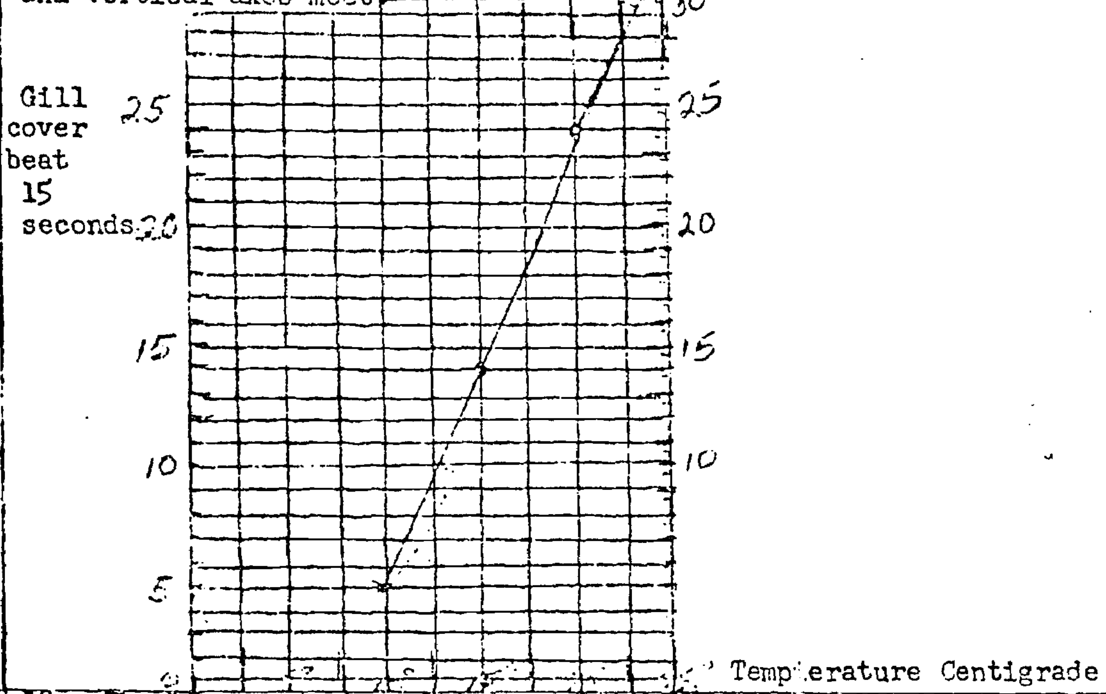
---

15. The numbers to be written on the vertical axis are a matter of choice. The number of gill cover beats ranged from 5 to 32. We could have numbered the marks on the vertical axis 1, 2, 3, 4, to 32, but this would have crowded the vertical axis. Instead we chose the numbers 5, 10, 15 to 35. We could still mark any number from 5 to 32 on the graph and have the numbers on the vertical axis easy to read.
(Go on to the next frame.

16. The smallest number on the vertical axis is (nearest to/farthest from) __________ the point where the vertical axis joins the horizontal axis.

17. The temperatures used in the experiment were 10, 15, 20, and 25°C. The lowest temperature (10) was recorded on the horizontal axis (nearest to/farthest from) ________ the point where the horizontal and vertical axes meet.

FIGURE 1



18. The line of the graph connects four dots. Look at the dot in the lower left-hand corner of the graph. The dot is directly above the mark on the horizontal axis that represents _____ °C.

19. The dot in the lower left-hand corner of the graph is directly opposite and to the right of the number on the vertical axis that represents (number) ______ gill cover beats per 15 seconds.

20. If you interpret the graph correctly the dot means that in the experiment the gill covers of the goldfish beat:
a. 10 times (per 15 seconds) when the temperature was 5° C.
b. 5 times (per 15 seconds) when the temperature was 10° C.

21. You said the gill beat cover moved 10 times when the temperature was 5°C. Take another look at the horizontal axis. It is labeled

__________ __________.

You find (temperature centigrade/gill cover beat) values on this line.

__________.

22. When the dot is over the 10°C mark it means that the temperature reading was ______ °C.

23. Therefore, if the dot is to the right of the number 5 on the vertical axis, the gill covers of the goldfish beat (number) ______ times (per 15 seconds) when the temperature was 10° C.

24. The gill covers of the goldfish beat 5 times per 15 seconds when the temperature was 10°C. The dot directly above 20°C on the horizontal axis was placed opposite (number) _____ because at 20°C the gill cover was (number) _______ times per 15 seconds.

25. Each dot on the line represents information concerning the relation of the ________________ to temperature in the experiment.

26. After the dots were placed on the graph a line was drawn connecting them. Notice that the line slopes upward from the left to the right.
At the lowest point of the line the temperature is _____°C, and the rate of gill cover beat is (number) _________.

27. At the second dot, moving up the slope of the line from left to right, the temperature is _____°C, and the rate of gill cover beat is (number) _________.

28. At the third dot the temperature is _____°C, and the rate of beat is (number) ________.

29. Finally, at the last dot the temperature is _____°C; the rate of gill cover beat is (number) _________.

30. Thus the slope of the line, by going upward from left to right, shows a relation between temperature and rate of gill cover beat. You would say then that as the temperature (increases/decreases)______, the rate of gill cover beat (increases/decreases) _______________.

31. In another experiment using a rainbow trout, the following data were obtained:

Temperature	10°C	15°C	20°C
Gill cover beats	7	25	42

These data were plotted on the same graph to produce the left-hand line in Fig. 2. (Go on to the next frame.)

32. With an increase in temperature from 10°C to 20°C in the trout, the rate of gill cover beat increased from _____ to ______ (number).

33. Look at the line on the graph made from the goldfish data. For the goldfish a rise in temperature from 10°C to 20°C increased the rate of gill cover beat from _______ to ________. (number)

34. For the same temperature difference (10°C to 20°C), the rate of increase of gill cover beat in the trout was (greater/less) _______ than in the goldfish.

35. Compare the two lines on the graph (top of page 5). The line for the trout is (more vertical/less vertical) __________ than the line for the goldfish.

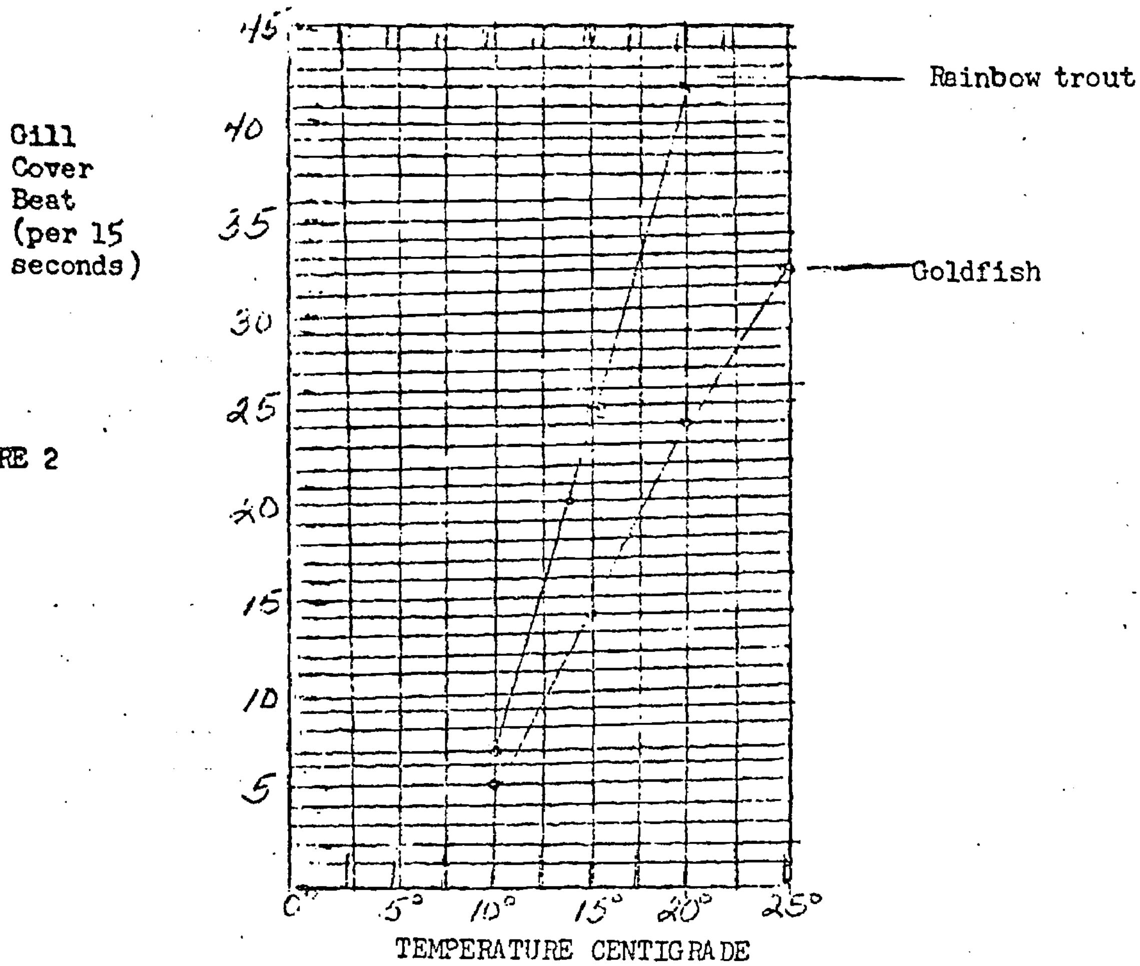
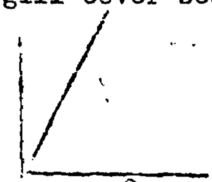


FIGURE 2

36. The more vertical the line in the graph we are looking at, the (faster/slower) ______________ is the rate of gill cover beat for any given temperature.

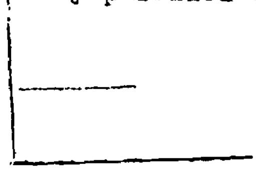
37. Which of these two graphs represents a greater increase in the rate of gill cover beat as the temperature increases? (A/B)____________



A

B

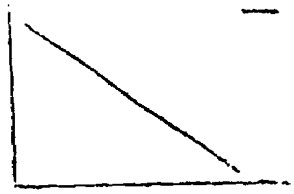
38, If the line of a graph is exactly parallel to the horizontal axis as,



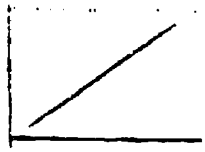
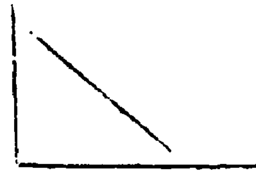
the gill cover beat (decreased/increased/stayed the same)

____

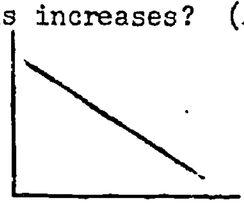
39. If, on the same type of graph, the line sloped downward from left to right, as shown in the drawing, this would mean that, as the temperature increased, the gill cover beat (increased/stayed the same/decreased) ______________



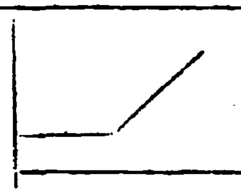
40. If, on the same kind of graph, one line slopes upward from left to right, as in graph B, then graph A shows a (decrease/increase) __________ and graph B shows a (decrease/increase) __________.

A


B

41. Consider these two graphs.
Which graph shows a faster decrease for the value on the vertical axis as the value on the horizontal axis increases? (A/B) __________.

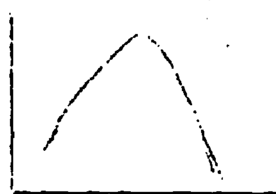



42. If the line on the graph looked like this, it would mean that the gill cover beat stayed the same awhile and then (decreased/ increased). __________

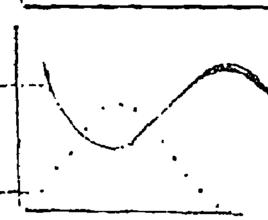


43. If the line on the graph looked like this, it would mean that the gill cover beat decreased awhile and then (increased/ stayed the same)
____

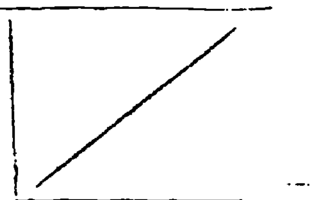
44. If the line were drawn like this, the gill cover beat would __________ awhile and then __________.



45. If you saw a graph like this, you would state that the gill cover beay beat for the goldfish __________ and then __________ while for the trout it increased and then __________.

Goldfish
Trout


46. In this graph, the number of people __________ as the number of years (increased/ decreased) __________.

Number of people -->

Number of years-->

COLLECTING AND GRAPHING SCIENTIFIC DATA

Name________________

Group______________

EFFECT OF TEMPERATURE ON GOLDFISH RESPIRATION RATE

Purpose: To collect and graph data on the effect of a change in water temperature on the respiration rate of goldfish.

Background Information:

The respiratory cycle in the fish is accomplished when water laden with oxygen enters the mouth and is forced out over gill filaments when the mouth is closed. The oxygen dissolved in the water enters capillaries in the filament and the excess carbon dioxide in the capillaries is released into the water. The gill cover (operculum) opens to allow carbon-dioxide laden water to leave the gill chamber, thus completing the respiratory cycle. Counting the movement of the operculum therefore is one method of computing the respiratory rate of the goldfish.

Materials:

1. Goldfish
2. Beakers
3. Thermometer
4. Aquarium water
5. Boiled water (hot tap water is adequate)
6. Ice

Procedure:

1. Put goldfish in beaker of aquarium water and observe relationship of mouth and gill movement, stirring water carefully.
2. Place a thermometer at one edge of the beaker so you can record temperature.
3. Observe the movement of the gill cover or mouth. Using a timing device count the gill movement or mouth movement for a period of 15 seconds. Record data in chart provided. Make another count and average the 2 counts.
4. Slowly add hot water a little at a time, making counts at 30°C and 35°C. Make sure to keep water volume constant and avoid exciting fish. Always take 2 counts, averaging the two.
5. Now start reducing the temperature by adding ice, making counts at 5° intervals, going down to 5°C.
6. After all counts have been made and data chart filled, construct a line graph from data.

Observation and Data Table:

DATA CHART

Temperature in C°	First Count (15 sec.)	Second Count (15 sec.)	Average
35			
30			
25			
Aquarium Temp. 2___			
20			
15			
10			
5			

Interpretation:

_____1. The relationship between the water temperature and respiration rate of goldfish is best described in:
A. the higher the water temperature the lower the respiration rate (inverse variation).
B. the lower the water temperature the higher the respiration rate (inverse variation).
C. the lower the water temperature the lower the respiration rate (direct variation).
D. temperature has no effect on respiration rate.

_____2. In addition to water temperature which one of the following factors seems to influence respiration rate least?
A. Amount of oxygen in the water.
B. Stirring of the water.
C. Size of the fish.
D. Size of the container.

_____3. The purpose of taking the respiration rate at normal aquarium temperature is to:
A. establish a control.
B. establish a variable

_____4. The dependent variable in this experiment is:
A. the size of the container.
B. the respiration rate.
C. the temperature of the water.
D. the size of the fish.

_____5. The independent variable in this experiment is:
A. the size of the container.
B. the respiration rate.
C. the temperature of the water.
D. the size of the fish.

_____6. Based on experimental observations which of the following predictions would seem to be least reasonable?
A. A snake would hibernate during the winter season.
B. Frog eggs develop during warm weather.
C. Bacterial growth in food is reduced during refrigeration.
D. Respiration rate of man increases as physical activity decreases.

QUIZ I-A: "Introduction to Biology

Directions: Select the most correct answer and place the letter on the answer sheet provided.

(1.1) Louis Pasteur disproved the belief in spontaneous generation of:
(A) Microorganisms (B) Maggots (C) Flies (D) Mice

(1.2) The area of biology devoted to the study of the structure of organisms is:
(A) Physiology (B) Anatomy (C) Ecology (D) Genetics

(1.3) Of the following choices, which one best illustrates the sequence of the Scientific Method?
(A) Theory, hypothesis, observation, experiment
(B) Experiment, theory, hypothesis, observation
(C) Hypothesis, observation, theory, experiments
(D) Observation, hypothesis, experiment, theory

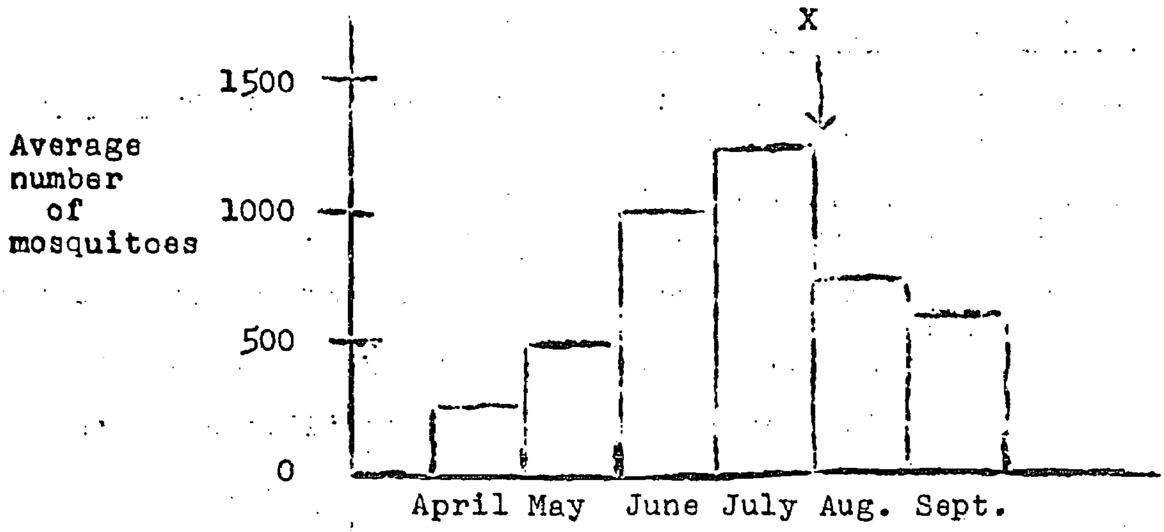
(1.4) The idea that living things may have arisen spontaneously under certain environmental conditions is an example of ?
(A) hypothesis (B) fact (C) data (D) experiment

(1.5) Several rose buds were selected for an experiment. One half of them were placed in a container filled with tap water. The other half were placed in a container identical to the first, filled with tap water in which one dozen aspirins had been dissolved. The experiment was designed to test the hypothesis that:
(A) water is necessary to keep rose buds alive.
(B) aspirin will purify the tap water.
(C) rose buds need aspirin to produce food.
(D) aspirin has an effect on rose buds.

(1.6) Given the information that a scientist will
1. communicate his findings to others.
2. gather information by observations.
3. search for regularities.
4. question the regularities.

The logical order in which the scientist will perform these activities is:
(A) 4, 2, 3, 1
(B) 2, 3, 4, 1
(C) 3, 4, 2, 1
(D) 4, 3, 2, 1
(E) 2, 4, 3, 1

(1.12) On a series of biology quizzes, a student made the grades 68%, 79%, 83%, 92% and 73%. What was her average grade?
(a) 77% (b) 79% (c) 81% (d) 83% (e) 85%



A biologist interested in mosquito control made regular counts of the mosquitoes in the air over a marsh. He made a graph of numbers of mosquitoes found at various times. On July 31 chemical X was sprayed over the marsh area.

(1.7) In September the number of mosquitoes count was half the number counted in
(A) May (b) June (C) July (D) August

(1.8) In the construction of this graph, the dependent variable is
(A) number of mosquitoes.
(B) months April through September.
(C) placed on the Y axis.
(D) placed on the X axis.
(E) both A and C.
(F) both B and D.

(1.9) From his observations, the biologist could state the long range (that is, more than a few months) effect of spraying with X on the number of mosquitoes was:
(A) a decrease (B) an increase (C) no change (D) not known.

(1.10) In order to make a more valid interpretation of the results of spraying with X, the biologist should spray June 30 next year with
(A) X in the concentration used in the first test.
(B) X in twice the concentration used in the first test.
(C) a substance Y, known [illegible] to affect mosquitoes.
(D) a substance Z, known to kill mosquitoes.

(1.11) The relationship between the average number of mosquitoes and the time after the chemical was used, may be described [illegible]
(A) a direct variation
(B) an inverse variation
(C) a reverse variation
(D) no variation at all
(E) incomplete variation

LAB ACTIVITY: NAME ____________

LAB EQUIPMENT GROUP ________

Introduction

Glassware, instruments, and other scientific equipment have specialized purposes. You will be using many of these items and it is important that you recognize each and be aware of its function.

Purpose

To acquaint each student with some of the many biological tools that will be used in later laboratory studies.

Materials

Various labware
Data sheet
Pencil (no pen)
Ruler

Procedure A

There are many pieces of scientific equipment located throughout the room. Each item is identified by a different number. You will be required to inspect all of these and identify them by name.

1. Take your data sheet and checklist with you to the first unknown.

2. Write down the name of the item if you think you know it. Place this name next to the correct number on your data sheet Do this in pencil!

3. Repeat steps 1 and 2 until all unknowns are inspected.

4. Return to your seat and correct your indentifications. Place a check mark before the number of each incorrect answer.

Procedure B

1. You will now return to each incorrectly identified item. Take your data sheet with you.

2. Make an accurate scale drawing on the back of your data sheet for each of your wrong identifications. Print a neat label under each sketch.

3. Return to your seat and study those you had wrong until you feel that you know them well enough to pass the quiz.

QUIZ I-B-1a:
Lab Equipment

Grade ____

NAME ____________

GROUP ____________

____1.	Made of glass; specimen placed here	a.	Forceps
____2.	Cleans out narrow, cylindrical glassware	b.	Thermometer
____3.	Magnifies minute objects about 450 times	c.	Metric ruler
____4.	Device that measures heat variations.	d.	Slide
____5.	Metal support; used to heat containers	e.	Balance
____6.	Soft, fibrous material; cleans glass	f.	Beaker
____7.	Graduated in millimeters; measures length	g.	Compound micro-scope
____8.	Glass container; volumetric, uniform wide diameter	h.	Test tube brush
____9.	Metallic; used to pick up small objects	i.	Ring stand
____10.	Used to weigh materials	j.	Lens paper

QUIZ I-B-1b:
Lab Equipment

grade ____

Name ____________

Group ____________

____1.	Plastic square; placed over specimen	a.	Test tube rack
____2.	Heat source, uses natural gas	b.	Test tube holder
____3.	Used to grip hot, tubular cylinder	c.	Balance
____4.	Magnifies larger objects up to 30 times	d.	Eye dropper
____5.	Tubular, glass, marked for volume measure	e.	Cover slip
____6.	Weighs materials metrically	f.	Erlenmyer flask
____7.	Wooden support for tubes	g.	Dissecting micro-scope
____8.	Dispenses fluids drop by drop	h.	Bunsen burner
____9.	Rectangular glass, specimen pre-mounted	i.	Graduated cylinder
____10.	Glass container, volumetric, wide base, narrow neck	j.	Prepared slide

STUDY ASSIGNMENT:
MICROSCOPY

NAME________________

GROUP__________

1. ALWAYS use both hands when transporting microscope. One hand on arm, one hand under base.

2. ALWAYS clean the mirror and ocular with lens paper before using the microscope. Avoid rubbing in circular motion due to scratching - use one-way motion.

3. ALWAYS be sure that you have the brightest possible light through your microscope BEFORE placing any slide on the stage.

4. ALWAYS set the fine adjustment knob in the middle at the beginning of microscope work and, thereafter, NEVER MOVE IT more than one-half of a slow turn in either direction.

5. NEVER change from the low power objective to the high power objective unless the specimen is IN FOCUS first under the low power objective.

6. ALWAYS focus with low power objective down at slide and focus by bringing objective up with coarse adjustment.

7. NEVER touch the coarse adjustment knob when the high power objective is IN POSITION.

8. NEVER remove a slide from the stage of the microscope when the high power objective is in position.

9. ALWAYS have ONE HAND on the fine adjustment knob or coarse adjustment knob ANYTIME you are looking into the ocular of the microscope BUT REMEMBER RULE #5.

10. NEVER use more than one hand at any time on either or both the fine adjustment knobs.

11. DO NOT SQUINT: KEEP BOTH EYES OPEN AT ALL TIMES.

12. ONLY two (2) places for PREPARED OR PERMANENT SLIDES.

    A. In the correct position in the slide tray in the slide drawer.

    B. On the stage of your microscope.

NO OTHER PLACE
(except when moving from the drawer to your table.)

Name ____________________

Group: ____________________

THE MICROSCOPE

I. Base ---- The U-shaped bottom of the scope. The scope is always carried from cabinet to table with one hand firmly under the base; the other hand is used to grasp the "arm".

II. Mirror ---- Located between the base and the stage of the scope.
   A. Concave surface to focus light rays through the opening in the stage.
   B. Two-ways adjustable; should be constantly under minor adjustments during any prolonged use of the scope.
   C. Cleaning ---
      1. Always clean before using at beginning of scope work.
      2. Use "lens" paper ONLY.
      3. Try to avoid touching with the fingers at any time.

III. Arm --- placed nearest to your body when using the scope. This is used primarily to move the scope from place to place.

IV. Stage --- The part of the scope upon which objects, slides or specimens are placed for observation.
   A. Stage clips --- to hold objects or slides in place. We will never use these in our lab. unless advised to do so at special times. You will soon learn why it is that good microscopists would never use them for the kinds of work you will be doing with your scope.
   B. Stage Opening --- admits light from the mirror below.
   C. Light regulator --- a wheel which turns to vary the amount of light admitted through the stage. opening. Located just under the stage. Always leave on the largest opening unless otherwise instructed to cut down the light.
   D. Inclination joint --- permits tilting of the stage. WE WILL NEVER USE this unless advised to do so at a special time for a special reason.

V. Barrel --- An air filled tube bounded on either end by a lens.
   A. Ocular or Eyepiece --- the lens at the top of the barrel.
      1. the lens to which you apply your eye.
      2. cleaning --- always use lens paper.
      3. magnification --- 10X
   B. Revolving Nosepiece --- permits change of magnification;
      --- changes from the 10X objective to the 43X objective;
      --- makes a "clicking" sound when the objectives "snap" into position.
      --- hold the arm of the scope with one hand when turning the revolving nosepiece. (I will demonstrate why).

1. Low Power Objective ---
   a. color of band --- green
   b. length --- shorter of the two
   c. magnification --- 10x
   d. working distance --- 16 mm.
   e. lens diameter --- larger of the two
   f. total magnification: (__________)

2. High Power Objective ---
   a. color of band - yellow - (CAUTION - DANGER)
   b. length --- longer of the two
   c. magnification --- 43X
   d. "working distance" ___ 4 mm.
   e. lens diameter --- (__________)

VI. Adjustments.

A. Coarse Adjustment Button or Knob.
   1. Location --- nearest to the top of the scope - along the side of the barrel.
   2. Function --- moves the barrel considerable distances --- MOVE SLOWLY -
   3. N E V E R T O U C H E D W H E N T H E HIGH POWER OBJECTIVE IS IN POSITION.

B. Fine Adjustment Button Knob.
   1. Location -- under the stage.
   2. Function -- moves the barrel very small distances

      M O V E S L O W L Y

      WITH ONE HAND ONLY

   3. Control -- moves 6 -7 full turns from one binding post to the other.
   4. NEVER FORCE -- This adjustment is easily broken. Always use care in turning and TURN slowly.
   5. Readiness position --- about three or four turns from either end at the beginning of each period of microscope use.

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3. Directly above the mirror is the DIAPHRAGM. This object controls the amount of light the ________ reflects through the diaphragm into another part of the microscope.

4. The diaphragm (is not/is) ________ directly above the mirror.

5. The ______phragm controls the amount of light reflected into another part of the microscope.

6. The diaphragm is labeled (number) ______ in Fig. A.

7. Can you find a lever or a disc on your microscope that permits you to make the opening in the diaphragm larger or smaller?
It is labeled (number) ______ on your drawing.

8. Check the items below that you have examined.
______ mirror (or light)
______ low power lens
______ diaphragm lever or disc
______ diaphragm

9. Above the diaphragm there is a clip. It is labeled 4 in Fig. A.

Locate the clip. It holds a slide in place. There may be two clips on your microscope.

(Go on to the next frame.)

10. Label the parts of this area of the microscope.

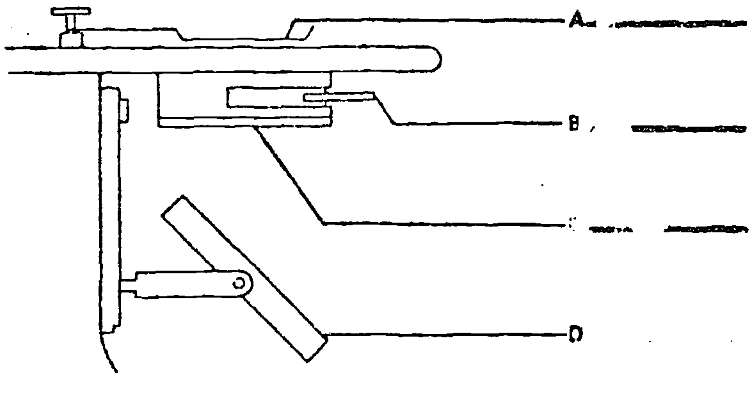


Figure B

11. Look at Fig. C. It represents another portion of your microscope. It has three basic parts. A HIGH POWER OBJECTIVE, a LOW POWER OBJECTIVE, and a REVOLVING NOSEPIECE.

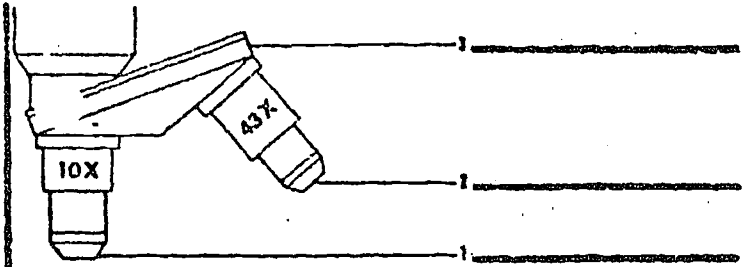


Figure C

12. Is the part in Fig. C with *10X* marked on it (longer/shorter) __________ than the part marked *43X*?

13. The number 10 is *smaller* than the number 43, so we would call the part with *10X* the (high/low) __________ POWER OBJECTIVE.

14. Look at Fig. C. Is the low power objective marked *10X*? It is labeled (number) ______.

15. The *high* power objective is marked ______X. Write its name alongside the number 2 in Fig. C.

16. The two __________ in Fig. C are called *high* and *low* power.

17. Check the parts for this portion of the microscope that you have just identified:

______ revolving nosepiece
______ high power objective
______ 10X objective

18. The part still to be identified enables you to change the objectives from one power to the other. It is called the *revolving* __________.

19. The part that has objectives attached to it and that revolves is called the volvingre oseniecpe ________ ________ (unscramble the letters)

20. The revolving nosepiece is labeled (number) ______. Write its name alongside the correct number in Fig. C.

21. irectly above the revolving nosepiece is a tube. It is calleu the body tube. In the drawing in Fig. D the body tube is labeled (number) ______

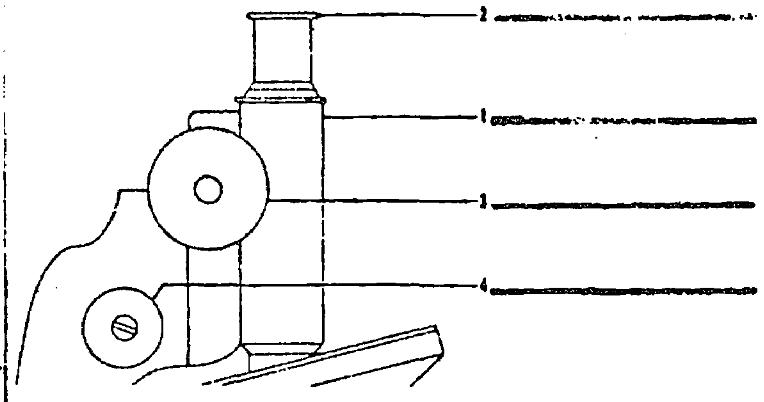


Figure D

22. To look into the body tube you place your *eye* at the __ __ __piece.

23. The eyepiece is located at the top of the body tube. Look at Fig. D. The eyepiece is labeled (number) ______.

24. Write the correct label alongside number 2 in Fig. D.

(Go on to the next frame.)

25. Now see if you can find the two parts labeled *3* and *4* in Fig. D. They (are/are not) __________ round objects.

26. Depending on the model of your microscope, you may find these round objects close to the eyepiece or possibly near the lower portion of the microscope.

(Go on to the next frame.)

27. The round object labeled *3* in Fig. D is (larger/smaller) __________ than the one labeled *4*.

28. We call the larger one labeled *3* the COARSE ADJUSTMENT. Write the correct label alongside number *3* in Fig. D.

(Go on to the next frame.)

29. The coarse adjustment permits you to move the body tube and so does the adjustment marked *4*. This smaller round object is called the FINE ADJUSTMENT.

(Go on to the next frame.)

30. The __________ adjustment is smaller than the coarse adjustment. Write the correct label next to *4* in Fig. D.

31. Check the names of the parts you have just learned.

______ fine adjustment
______ base
______ eyepiece
______ arm
______ body tube
______ coarse adjustment

15. Switch to high power again. Remember, use *only the fine adjustment to sharpen the image of the "e"*.

    Do you see more of the "e" or less of the "e"? ______________________________

16. Move the slide with the "e" to the right as you did before. The "e" moves to the ________________.

17. Move the slide with the "e" up, as you did before. The "e" moves________________.

18. Choose *one* of the following materials, and make a slide:

    HAIR: Cut several strands of hair from your head. Put them on a slide, add a drop of water, and cover with a cover slip.

    Cloth: Cut a small piece of cotton or wool cloth to put on a slide. Add a drop of water, and cover with a cover slip.

    Sand: Place several fine sand grains on a slide. Add a drop of water and cover with a cover slip.

    Focus first in low power, using the coarse and fine adjustments. In the space below make a drawing of what you see under the low power of your microscope.

19. Switch to high power, using *only the fine adjustment* to sharpen the image. Make a drawing below of what you see in the microscope.

20. Return all the laboratory materials to their proper places. Ask your teacher to check pages 62 and 63 and initial the box at the end of this line. ☐

THE COMPOUND MICROSCOPE

CONCEPTS

It was a Dutchman, Anton van Leeuwenhoek, who invented the microscope in the middle of the 1600's. No one before him realized that a drop of water could contain so many animals and plants. He was the first to see these microscopic living things.

Of course, without the aid of the microscope man would have never known that such an invisible world existed. Man has always invented tools to widen the limits of his world, to reach where his senses could not reach.

Learning how to use the microscope will give you an extension of your eyes to see the invisible world.

1. Your teacher will give you a *compound microscope*. Notice how your teacher holds it. Place the microscope on your laboratory table, but do not turn any of the knobs yet.

2. Remove the last page of this book which contains a drawing of the compound microscope. As you read about each part, *label that part* on the cover drawing. Your microscope may be slightly different from the one in the drawing.

   Notice the *arm* (3) on your microscope. (The 3 refers to the drawing on the back cover. Label the arm on this drawing.)

   When you carry the microscope, hold the arm with one hand, and the *BASE* (10) with the other. But be careful, you will be carrying an instrument that is valued from $100.00 to $200.00. Label the base on the drawing.

3. Place the microscope in front of you, so that the arm is nearest to you. Why should the microscope not be too close to the edge of the table?__________

   ____

4. To look into the microscope you will look through the *EYEPIECE* (1) down through a tube. The eyepiece magnifies objects 10 times. Keep both eyes open when looking through the eyepiece.

5. The bottom of the tube contains several other lenses:

(a) The *LOW POWER LENS* (6) This magnifies objects 10 times also.

(b) The *HIGH POWER LENS* (5) This magnifies objects 40 to 44 times. The amount of magnification will be marked on the side of the lens. Notice that the high power lens is the longer of the two lenses.

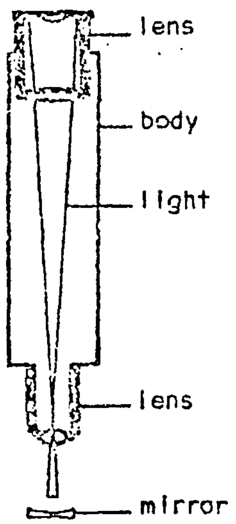
6. Each lens *clicks* into place, so that one of the lenses is in line with the lens in the eyepiece. Raise the tube, and *carefully* and *slowly* practice clicking the low power and the high power lenses in place so that they are in line with the eyepiece.

7. This kind of microscope is called a *compound microscope,* because you will be looking through more than one lens at a time--the lens in the eyepiece and the lens at the bottom of the tube.

(a) When you look at an object through the lens in the eyepiece and the low power lens, the object will be magnified *100 times*.

(b) When you look through the lens in the eyepiece and the high power lens, the object is magnified *over 400 times*.

(c) Always use *lens paper* to clean your lens. Any other kind of paper or cloth may scratch the expensive lens.



8. Light must be able to go through the material you are observing. To focus the light rays through the hole in the *STAGE* (8), your microscope may have a *MIRROR* (9), or it may have a built-in light source.

The amount of light can be adjusted by turning the disc or dial below the stage. This causes a smaller hole or a larger hole to be placed in line with the hole in the stage. Try it on your own microscope.

9. You will usually find two round knobs on your microscope.

The large knob, called the *COARSE ADJUSTMENT* (2) moves the whole tube up and down a great deal. The other knob, the *FINE ADJUSTMENT* (4), moves the tube so little that you can hardly see it move.

Try moving the tube *carefully* and *slowly* with both the coarse and fine adjustment.

10. Notice the *STAGE CLIPS* (7) on the stage. These hold the slide in place on the stage.

11. The care of the microscope is important. Answer the following questions:

    (a) Notice that the microscope can be tilted toward you in some models, making it easier for short people to use. What would happen to a drop of water if the stage were tilted? ______________________

    ____

    (b) Would the microscope tip over more easily if it were tilted? (circle one)
    yes   no

    Why should you not leave the microscope in a tilted position?

    ____

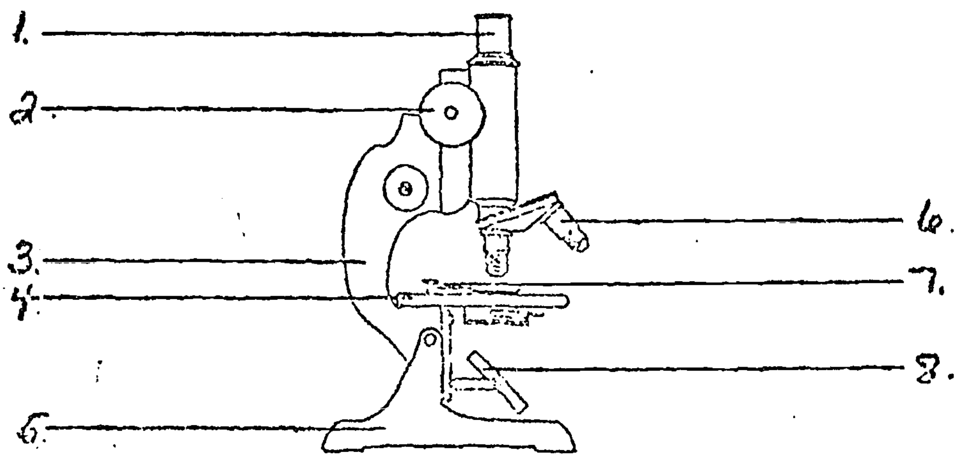
    (c) Why should you only clean the microscope lenses with special lens paper? ______________________

    (d) When the microscope is put away, first wrap the cord around the base (if it has an electric light), and put the low power lens in position. How will you carry the miscroscope? ______________________

    ____

12. As a review, answer the questions below without looking back or at the drawing on the back cover. Ask your teacher to check your answers on this page and the page before.

    (a) Label the parts of the microscope below:



(b) When you carry the microscope, one hand should hold the__________ and the other hand should hold the______________.

(c) This microscope is called a compound lens microscope because (circle one)

a. You look through the eyepiece.
b. You look through one lens only.
c. You look through several lenses at the same time.

(d) In *low power*, an object is magnified:

a. 100 times
b. 200 times
c. over 400 times

(e) In *high power*, an object is magnified:

a. 100 times
b. 200 times
c. over 400 times

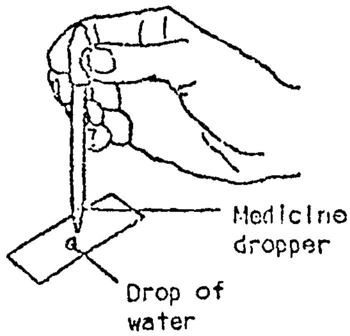
(f) Always use lens paper to clean the lens. true false

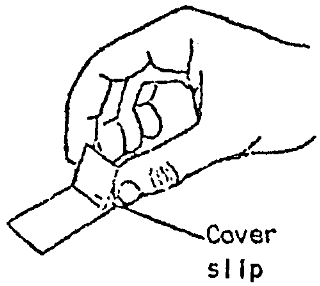
If your teacher approves, ask to have the box initialed. ☐

LABORATORY INQUIRY--MAKING A SLIDE

Now that you know the parts of the microscope, you are ready to use it.
Get the following materials from your teacher:

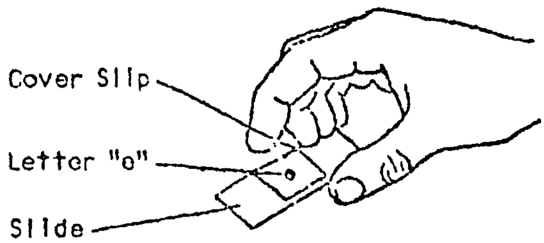
MATERIALS
___1. slide
___2. cover slip
___3. medicine dropper
___4. 250 ml beaker
___5. scissors
___6. compound microscope





1. Cut out the square with the "e" in it at the lower right corner of this page.

2. Put the square on the slide so that the "e" is upside-down. Add a drop of water with a medicine dropper, and cover with a cover *slip*, which is a thin square of plastic or glass. Your slide should look like the one at the right.



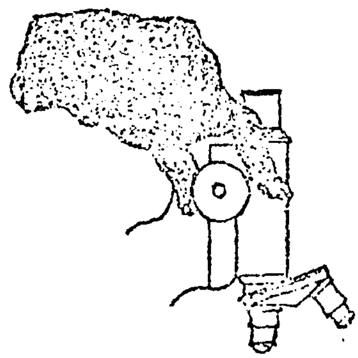
The cover slip helps to protect the low and high power lenses, and it helps to keep the preparation from drying out.

3. Clip the slide under the stage clips on the microscope. Make sure the upside-down "e" is over the hole in the stage.

4. Click the *low power lens* in position.

5. Looking from the *side*, use your *coarse adjustment* to lower the tube until the low power lens almost touches the cover slip.

6. Now, look into the eyepiece (keeping both eyes open), and with the coarse adjustment begin to *raise* the low power lens. Bring the "e" into focus.



e

7. Use the fine adjustment to bring the "e" into even sharper focus.

8. Now, without touching the coarse or fine adjustment, click the high power lens into place. Your microscope is built so that if you focus correctly in low power, it will be focused automatically in high power.

9. You may now make the image clearer by using the *FINE ADJUSTMENT ONLY. NEVER USE THE COARSE ADJUSTMENT ON HIGH POWER* because it may ram the high power lens into the slide, breaking the high power lens.

REMEMBER

(a) Focus first in low power by using the coarse adjustment and then the fine adjustment.

(b) Switch to high power. Use the fine adjustment to sharpen the image, but *never use coarse adjustment.*

10. Now that you have focused the "e" on your slide in low power and high power, you are ready to answer the questions below. Use the slide you have made in answering the questions. Your teacher will give you the correct answers.

To focus your microscope, you must first focus in ___A___ power. Then, you may switch to ___B___ power. On high power, you use only the ___C___ adjustment to sharpen the image. On high power never use the ___D___ adjustment.

11. Switch back to low power. Sharpen up the image of the "e". In the space at the right draw the "e" just as you see it in your microscope.

12. Look at the "e" on your slide, not looking through the microscope. Then look at the "e" through the microscope. Name two things which appear different about the "e" when you look at it through the microscope:

(a) The "e" is ________________________ .

(b) the "e" is ________________________ .

(c) the "e" is ________________________ .

13. While looking through the microscope, move the slide with the "e" to your right. Which way does the "e" appear to move in the microscope? The "e" moves to the ____________ .

14. While looking through the microscope, move the slide with the "e" up (or away from you). Which way does the "e" appear to move in the microscope? The "e" moves ______________ .

FOR RECORDING DATA: Observations, Predictions, Drawings, Tables, Graphs

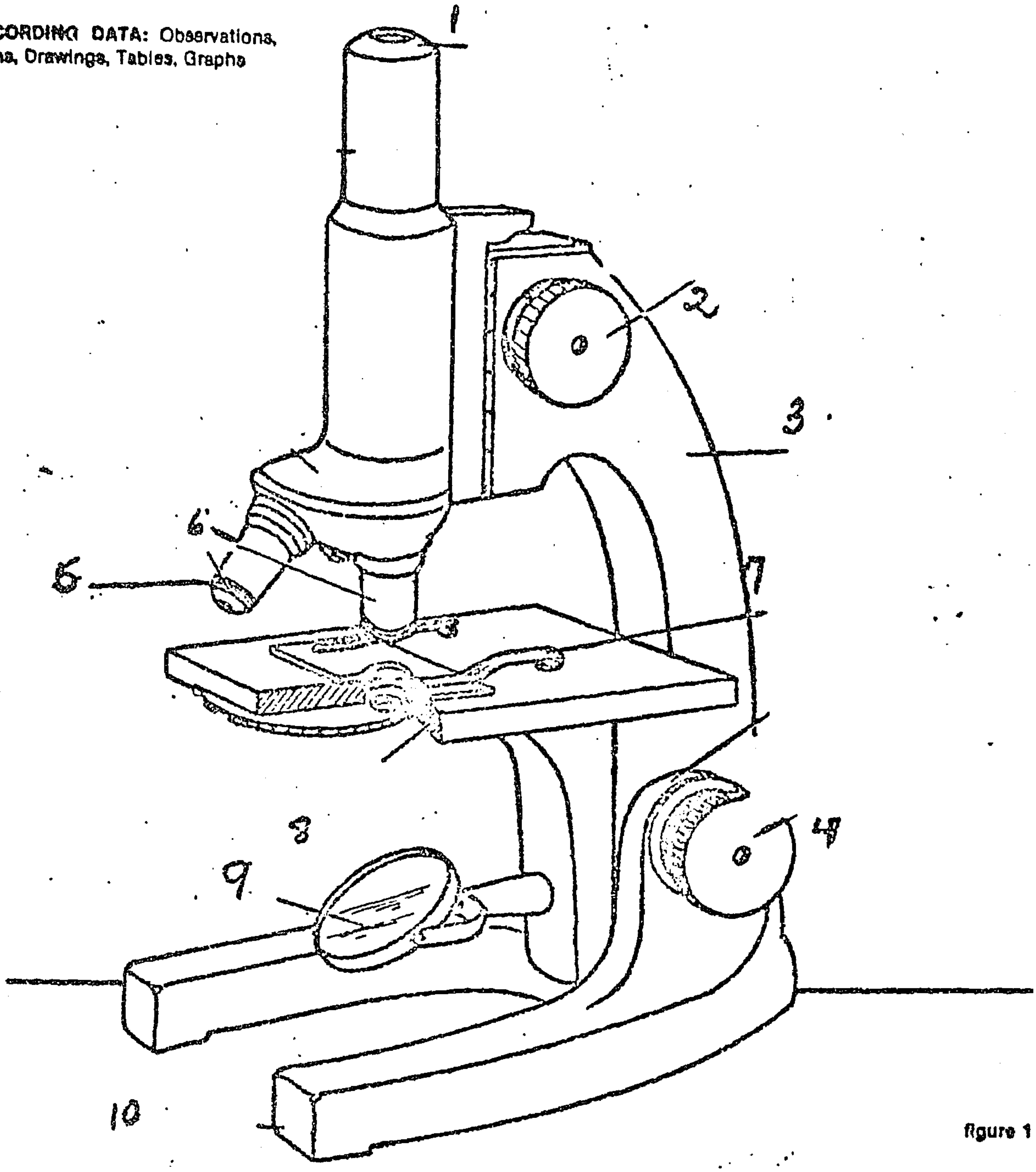


figure 1

LAB - COMPOUND MICROSCOPE

Introduction

The progress of science depends on both tools and ideas. Laboratory instruction in biological science is designed to make you familiar with some of the more important tools and show you how those tools are used to explore ideas, thus answering old questions and generating new ones. For more than two centuries, the principal tool of the laboratory biologist has been the microscope. Through its use, biologists of the 19th century arrived at that great milestone in the study of living things, the cell theory. In the weeks and months to come, we shall study some of the evidence that supports this theory, but before doing so we need to become familiar with the tool that we are going to use, the microscope.

Optical microscopes are of two kinds, simple microscopes and compound microscopes. A simple microscope has but a single lens, like the familiar magnifying glass. Such lenses are usually of low power, typically magnifying each linear dimension about ten times (10X); but is is possible to make tiny, highly curved lens that magnify much more. The 17th century biologist Leeuwenhoek carried out his pioneering studies using simple microscopes with magnifying powers of some 200X.

Compound microscopes, by contrast, have two or more lenses in series to produce the image. Useful magnifications as great as 1800X are obtainable with such instruments. Most basic biological observations can be made, however, with much less magnification. The micro scopes you will use offer a choice of two most useful magnifications, one about 100X, and one about 430X.

Use of the Microscope

The outstanding purpose of the microscope is to magnify the image of objects, and thereby enable one to study the detailed structure of minute objects or organisms, invisible or poorly seen with the naked eye. This magnification depends on the lens of the ocular and of the objectives, particularly the objectives.

When we speak of the 10X ocular we mean that it magnifies the original object 10 times in diameter. On the other,hand, when we speak of the 16 mm. objective, we do not mean that it magnifies 16 times, but we are referring to the distance from the slide to the objective called the working distance.

(1) What are the total magnifications obtained with the different combinations of lenses? Give the ocular, objective, and total magnifications for each combination.

Focusing the microscope

To focus a microscope means to adjust the relation of the lenses to the object so that a clear image of the object may be seen through the ocular. The image of the object cannot be seen unless the objective is at the proper distance from it, in other words, unless it is in focus. Locate again the course adjustment button. Turn it a bit toward you counter-clockwise and note that the tube or barrel moves upward. Practice the operation of the coarse adjustment button back and forth; then do likewise with the fine adjustment button which will cause a barely perceptible up and down movement of the tube.

Raise the objective about one inch above the stage by turning the coarse adjustment button. Stand a millimeter ruler on the stage so the [illegible]le touches the structure into which the objectives are screwed.

(2) Through how much of a turn must the coarse adjustment button move in order to cause the objective to move one millimeter?
Hint: First find out how much it moves with a full turn; then work backwards.

Care of the Microscope

1. The microscope is an instrument of precision with many delicate parts and must be handled with extreme care. Do not tamper with or remove any of the parts.
2. If it does not seem to be functioning properly, call it to my attention.
3. Keep the lenses and mirror clean with your lens paper.
4. Never touch the lenses or mirror with your fingers. Even slight perspiration of otherwise clean hands will injure the special lens glass which is soft and easily marred.
5. When returning the microscope to its place of storage, always make sure that the low power objective is in position about one-half inch above the stage.

Practical Exercise

NOTE: IF YOU DO EXACTLY AS YOU ARE TOLD IN EACH OF THE FOLLOWING STEPS I WILL GUARANTEE THAT WITHIN THIRTY MINUTES YOU WILL BE SEEING THINGS WITH YOUR MICROSCOPE AND DOING SO IN THE CORRECT WAY.

1. Place the microscope directly in front of you with the arm nearest to you.
2. Turn the low power objective until it clicks in place directly over the center of the stage. Look to one side of the objective and, with the coarse adjustment, lower the objective down to within 1/2 inch of the stage.
3. Turn the light regulator to its largest opening.
4. When looking into the microscope it is of the greatest importance that you keep both eyes open; the one not in use will soon learn to ignore its field of vision. Ordinarily, use your left eye for your microscope work and keep the right eye free for drawing and other work.
5. Turn on your lamp and, without turning the microscope from its regular position, adjust the mirror toward the source of light. Now, while looking through the ocular, regulate the mirror until you have a clear circular microscopic field evenly lighted. LAMPS ARE NEVER TO BE NEARER THAN TWO FEET FROM THE MICROSCOPE.
6. Prepare a wet mount using a small letter "e" cut from newsprint. Cover. Place this slide in the center of the stage so that the letter "e" will be directly over the opening in the stage. Rays of light may be seen passing through it. Again look from one side and lower the objective close to the cover glass of the slide. Now look through the ocular, and with the coarse adjustment, slowly focus up until a dark area of a letter comes into view. If no object appears, make sure that the "e" is exactly in position as directed and repeat the process.
7. Now slowly move the slide and examine all of the letter "e". Note that the letter is reversed and upside down. Focus on the letter and move the slide toward the right.

(3) In what direction does the letter move in the microscopic field of vision?

8. Turn to the high power objective, regulate the light, and carefully focus with the fine adjustment. Center a part of the letter under the high power and then turn on the low power to determine how far

off center the object is in your particular microscope. This is important and should aid you in all of your future scope work. Practice shifting from low power to high and back again. Note that only a small amount of manipulation with the fine adjustment is necessary to bring the object again into proper focus, whenever the objective is changed.

9. In starting a microscopic study, always examine the slide or object under the low power first. Get a good general idea of it and then, if necessary, bring the specific part to be studied into the center of the field for further examination with the high power. Despite the fact that students are requested to use the low power to find and center all objects desired for study, there seems to be a temptation on the part of some to start out with the high power. This is wrong, for it is extremely difficult to locate an object with the high power without using the low power first. Students damaging or breaking slides will be required to pay for them, usually at the rate of $1.00 or more for each permanent slide damaged. When through, at the end of each laboratory period, turn on the low power, remove the slide and place it in its proper place in the slide box.

Preparation of Materials for Observation

Material to be observed is mounted on a piece of glass 1 x 3 inches, called a slide. The material is covered with a very thin piece of glass, the cover glass. Clean a slide and cover glass by washing in water and then wiping with a small piece of paper towel. Place a small drop of water in the center of the slide by touching the dropper from the water to the slide and then forcing out the correct amount of water. Secure from students in the room a piece of dark hair one quarter inch long and a piece of blond hair the same length. With the forceps place these in the water on the slide so they cross. Set the cover glass on top of the crossed hairs so as not to trap air bubbles in the water.

A perfectly prepared slide has no entrapped air bubbles. But if your first slide is less than perfect, it is just as well, for you need to learn early what an air bubble looks like under the microscope. Otherwise you may later think you have discovered some wonderful new species of organism!! Before looking at the hairs further, find some air bubbles and study them carefully, using the fine adjustment to focus on various levels. Note the characteristic shading of the edges of air bubbles. You should now recognize them for what they are whenever you see them again.

Move the slide so that the place where the hairs cross is exactly in the center of the field.

(4) In which direction do the hairs appear to move when the slide is moved to the right?

Raise the objective with the fine adjustment to make the hairs appear just out of focus. Now lower the objective slowly and observe the hairs where they cross.

(5) Which hair comes into focus first?

(6) Is this hair on top of or below the other one?

(7) When the top hair is in focus, is the lower one visible?

(8) When the bottom hair is in focus, is the upper one visible?

With the hairs in sharp focus switch to the high power objective. WHEN USING THE HIGH POWER, FOCUS ONLY WITH THE FINE ADJUSTMENT. When the hairs are in focus with the high power, turn the fine adjustment to raise the objective and cause the hairs to go out of focus. Now lower the objective slowly with the fine adjustment.

(9) Which hair comes into focus first?

(10) Is this the top or bottom hair?

(11) When the bottom hair is in focus, is the top one also in focus?

(12) Is it visible?

You should now understand from these observations that a sense of depth in a microscopic field can be secured only by using the fine adjustment. Your mind becomes an active part in observation when you use the fine adjustment to get a sense of depth. As you focus while looking into the microscope you get a series of two-dimensional pictures which your mind ties together to give you a three-dimensional concept. THIS IS SO IMPORTANT THAT YOU MUST LEARN TO AUTOMATICALLY TAKE HOLD OF AND USE THE FINE ADJUSTMENT EVERY TIME YOU LOOK INTO A MICROSCOPE.

Colored Threads

Obtain the slide marked "colored thread slide" from your slide box and perform the same operations as described for the crossed hairs. Before you fill in the answers for the following questions, raise your hand and let me know what your decisions have been as to which color is on the bottom, which on the top, and which in the middle.

DO NOT USE HIGH POWER!!!

(13) Which color thread is on top?

(14) Which color thread is in the middle?

(15) Which color thread is on the bottom?

Measurement of Microscopic Objects

When microscopists wish to measure objects accurately, they usually place "ruled micrometer discs" in the ocular of the microscope. However, these discs are not available for use in high school classes. For this reason other means of estimating the size of small objects may be used. We shall use the millimeter ruler for this purpose today.

Place the ruler on the stage of the microscope and, with the low power objective, focus on the millimeter (mm) divisions.

(16) Approximately what is the diameter of the field of the low power objective?

The unit of microscopic measurement is the MICRON. A micron is equal to one-thousandth of a millimeter.

(17) What is the diameter of the low power field in microns?

Now switch to the high power objective and observe the mm. scale again. You will find that one of the black lines will almost cover the entire high power field. If you are going to determine the diameter of ...gh power field you must first try to estimate the width of one of ... lines in microns. To do this, return to the low power objective, focus on one millimeter again and try to estimate the width of one line by imagining how many times it could fit from one side of a millimeter to another.

(18) Give the approximate width of a line in microns.

Now, knowing the width of one line, return to the high power again.

(19) Give the diameter of the high power field in microns.

(20) If the length of a certain object is 1/10th the diameter of the low power field, what is the length of the object in microns?

(21) If the length of a plant cell is 1/5th the diameter of the high power field, what is its length in microns?

(22) If 30 cells in a row extend across the high power field, what is the average width of one cell?

(23) Under the low power observe one of the numbers on the scale of the ruler. Is it in the same position as when viewed with the naked eye?

(24) Is it (1) reversed, (2) turned through 90 degrees, or (3) inverted and reversed?

(25) How many centimeters in an inch?

(26) How many millimeters in an inch?

(27) How many microns in a millimeter?

(28) How many microns in a centimeter?

(29) How many microns in an inch?

(30) Express the dimensions of a certain animal. When viewed under the low power this animal extends in length 2/3rds of the way across the field and its width extends about 1/4th of the way across the field.

(31) Name, in proper order, all of the parts of the microscope through which a light ray will pass in going from the lamp to your eye.

LAB STUDY - NAME____________________

THE DISSECTING MICROSCOPE GROUP__________

Introduction

The dissecting microscope has advantages for some types of microscopic work. It consists of two complete microscopes, one for each eye, united to form a single instrument.

The dissecting microscope like the compound microscope, may be used to view objects by transmitted light. Usually, however, we use the dissecting microscope to look at objects by reflected light. This means that the observer looks at an object as he might view a book or his own hand. The object is visible because light is reflected from its surface. The dissecting microscope is useful for studying things that are too small to be observed with the unaided eye but too large to be seen as a whole with the dissecting microscope. Instruments of this type usually provide magnifications ranging from 5 to 60 diameters.

Purpose

Our purpose in this exercise is to learn how to make use of a dissecting microscope.

Materials and equipment

1. Glass slides
2. Half of a petri dish
3. Dropping pipette
4. Paper towel
5. Lens paper
6. Pond culture
7. Small dead insect
8. Piece of newspaper
9. Piece of cotton cloth
10. Dissecting microscope
11. Metric ruler

Procedure

A. Setting up the microscope.

Remove the microscope from the storage cabinet. Carry it to your laboratory table, using both hands. The instrument should be a safe distance from the edge of the table, in a position that is well lighted.

Calculate the magnification obtained when the low-power objective of your microscope is used. This is done by multiplying the magnification of one of the oculars by that of one of the objectives.
(1) What is the low-power magnification?
(2) What is the magnification at the higher power?

B. Observing with the dissecting microscope.

Begin by placing a metric ruler across the center of the stage. Using the focusing knob, move the body of the microscope as close to the stage as possible.

On your dissecting microscope the oculars are adjustable. Place one eye on an ocular and slowly raise the body by rotating the focusing know. Stop when the ruler comes into sharp focus. If the lenses of the oculars or objectives need cleaning, wipe them gently with a piece of lens paper. Next, move the oculars toward or away from the midline of the microscope until the distance between their centers matches the distance between the centers of your eyes. When this is done correctly, you see only a single circular field of view. Finally, without changing the position of the microscope body, rotate the movable tube until the ruler is in sharp focus again.

Now adjust your microscope so that it gives the lowest possible magnification.

(3) Using your metric ruler, measure the diameter of the low power field. (Use centimeters to tenths.)

Rotate the body tube to the higher power.

(4) What is the diameter of the higher field? (Use centimeters to tenths.)

Now place a small piece of newspaper on the stage and focus it sharply. While looking into the oculars, move the newspaper to your left.

(5) In what direction does the newspaper appear to move?

Now move the newspaper away from you.

(6) In what direction does it appear to move?

(7) How do these observations compare with those made using the compound microscope?

(8) Are the letters right side up (normal e) or upside down (inverted ∂)?

(9) Are the letters normal (e) or reversed (ɘ)?

(10) How do these observations compare with those made using the compound scope?

Now change the magnification to a higher power, and, if necessary, adjust the focus.

(11) Has the size of the field of view changed?

(12) If so, in what way?

Change back to low power and examine a small piece of lens paper; then examine a small piece of cotton cloth.

(13) How does the arrangement of fibers differ in those two materials?

Now place a small insect in the center of a clean glass slide. A cover slip should not be used. Place the slide on the stage and examine the insect, using low and high power objectives.

(14) Measure the length of the insect in centimeters to tenths.

Next, pour enough water from a pond culture into the petri dish to fill it to a depth of 3 mm. Examine under low and then high power, looking for different kinds of living organisms. Observe how they differ in size, shape, color and pattern of movement. Turn the light switch so that light can pass through the specimens. Note the difference in appearance when the same organisms are viewed by transmitted rather than by reflected light.

(15) Can you measure the length of one of your pond organisms? Try it. (Use centimeters to tenths!)

Finally, clean the stage of your microscope with a piece of soft paper towel. Adjust the magnification for low power, and turn the body down as far as possible before wrapping the cord around it. Clean all slides. Empty the petri dish into the pond culture container and dry it. Dispose of all other materials, as directed by your teacher.

LAB - THE DISSECTING MICROSCOPE   NAME ______________

GROUP ________

A. Introduction

A dissecting microscope has certain advantages for many types of microscopic work. Double eyepieces (oculars) and objectives provide stereoscopic (three-dimensional) vision. It can be used to view objects with reflected as well as transmitted light.

This instrument is used for dissections or observations of objects too large to be seen as a whole even with the low power of the compound microscope - your regular microscope. The usual magnifications vary from 20X to 60X.

B. Purpose

This laboratory study has three purposes: (1) to learn how to use this type of microscope; (2) to compare the compound with the dissecting microscope; (3) to observe a number of opaque and transparent objects.

C. Materials

Dissecting microscope	Dissecting needle
Strips of newspaper	Earthworm
Metric ruler	Pond culture
Bits of sand, sugar, dirt, seeds	

D. Procedure

1. Remove dissecting microscope from storage cabinet and carry to table using both hands.
2. Adjust the width of the oculars so that you can comfortably see with both eyes at the same time. These may simply be pressed toward the midline or pushed apart.
3. Place a strip of newsprint 10 cm. long and 1 cm. wide on the stage of the microscope. Use the coarse adjustment and move the objectives down as far as they will go.
4. Look through the oculars and raise the barrel slowly until the newsprint comes into sharp focus. It may be necessary to re-adjust the light and the focus. One of the oculars may now be adjusted for your own eyes.

Move the newsprint to the right and left.

(1) How does the image move?

Move the newsprint away from you and then toward you.

(2) Does the image move in the same direction?

(3) How does this compare with the regular compound microscope?

Change the objectives to the next higher power and, if necessary, adjust the light and focus.

(4) How does the apparent size of the image compare with the image seen under low power?

(5) How has the size of the field changed in this high power?

Return to the low power field. Using the information from the compound microscope calculate the magnification of the stereoscopic dissecting microscope.

(6) Low power? Then high power?

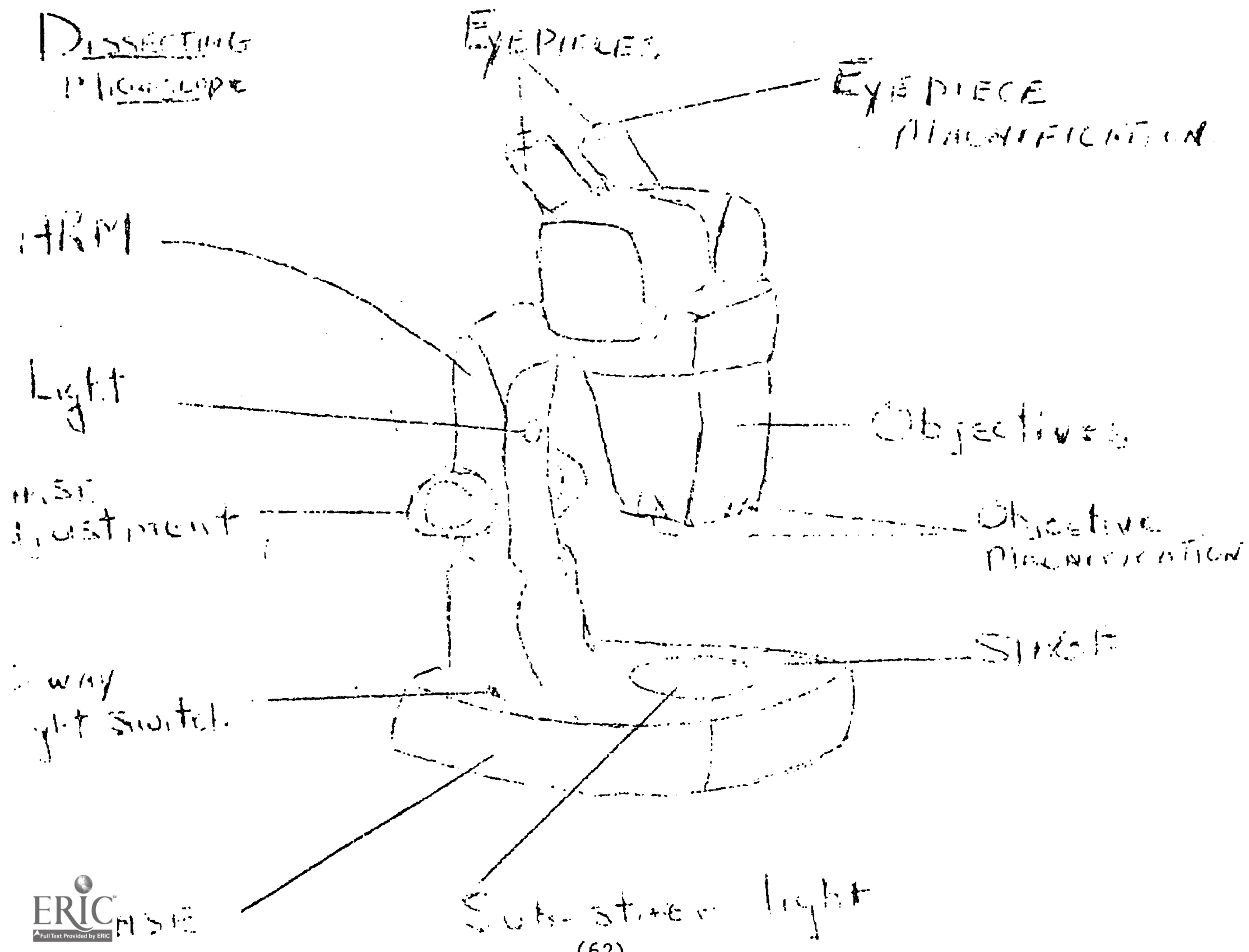
Return again to low power. This time compute the diameter of:
(7) Low power in cm., in mm., in μ
then to the highpower: in cm, mm, μ

Return once more to the low power objective. Examine a few grains of seed.
(8) How many can you get across the diameter?
(9) How many millimeters does it extend across the microscopic field?

Examine a preserved earthworm under the low power objective.
(10) Carefully count the number of segments.

Turn to the high power objective. Sprinkle some salt on a glass slide. Place the slide on the stage of the microscope so the salt is in view. Use a dissecting needle and arrange the salt crystals
(a) in a straight line.
(11) How many can you get across the diameter of the high power field?
(b) in a circle around the field of view.
(12) How many crystals does it take to form the circle?
(13) What is the shape of the crystals?

Turn your microscope to the high power magnification and observe a drop of the pond culture.
(14) How many different kinds do you see?



QUIZ I-B-2: "Optical Instruments"

(2.2) On a compound microscope, the circular substage object with holes of different diameters is called the
(a) disc diaphragm
(b) turret
(c) inclination joint
(d) revolving plate
(e) revolving nosepiece

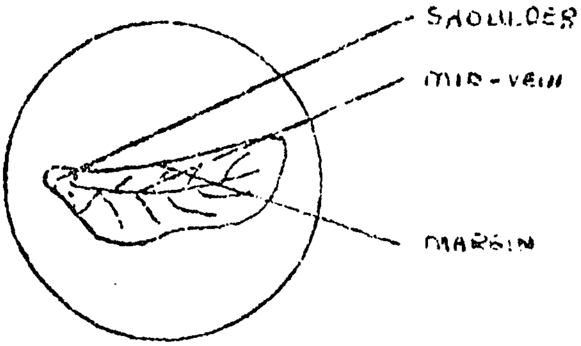
(2.3) On a dissecting microscope, the lens system farthest from the eye is called the
(a) ocular (b) turning plate (c) rotating disk
(d) revolving objective (e) revolving nosepiece

(2.4) Which of the following statements is a poor description of wet mount preparation?
(a) A cover slip is used to protect a specimen.
(b) The thumb should be used to apply firm pressure to the cover slip to hold it in place.
(c) A cover slip prevents the refraction of light away from the objective lens.
(d) A cover slip should be placed on the specimen as carefully as possible to prevent formation of air bubbles.
(e) One drop of water on the specimen is usually a sufficient amount.

(2.5) In order to examine a specimen under high magnification, the compound microscope adjustments should be made in the following order:
(a) Use the fine adjustment, lower the body tube, set coarse adjustment in the middle position, move low objective into place, move high objective into place.
(b) Set fine adjustment to middle position, lower body tube, fine adjust using high power.
(c) Lower the body tube, set fine adjustment to middle position, focus under low power, move to high power, use fine adjustment to refocus.
(d) Turn nosepiece to high power, focus, revolve to low power to locate the specimen, return to high magnification, refocus.
(e) Set fine adjustment to middle position, lower body tube, focus under low, revolve to high magnification, use coarse adjustment to focus.

(2.6) A student using a dissecting microscope has the field of view blurred by a dark vertical shadow. He should
(a) use a different specimen.
(b) refer to a textbook for help.
(c) adjust the movable eyepieces.
(d) try a different lighting combination.
(e) adjust the focusing knob near the specimen.

(2.7) This drawing of the wing of a fruit fly



(a) should be centered better.

(b) should be lettered better

(c) needs straight guide lines

(d) needs uncrossed guide lines

(e) needs to be finely shaded.

(2.8) A student returning two microscopes to the cabinet at once should
(a) be commended for efficiency.
(b) receive a good lab grade for finishing early.
(c) always be asked to help his lab partner.
(d) receive a poor lab grade for finishing early.
(e) receive a poor lab grade for carrying two microscopes at once.

(2.9) A prepared specimen moved toward you on the stage of a compound microscope seems to
(a) move to the left.
(b) move to the right.
(c) move away from you.
(d) move toward you.
(e) none of these.

(2.10) A specimen moved toward you on the stage of a dissecting microscope seems to
(a) move to the left
(b) move to the right.
(c) move away from you.
(d) move toward you.
(e) none of these.

READING: "MEASUREMENT SYSTEMS"   NAME____________________

GROUP______

Introduction: We are all familiar with the common units of measurement such as the inch, foot, mile, ounce, pound, and many others in the English system of measurement. However, in biology we use the metric system almost exclusively. It may be a little awkward for us when first using this system, but after a little practice we will find it is actually very simple to use.

For instance,
"There once was a student named Peter,
Who asked, "Why use METER and LITER?"
But when he found out
He let out a shout,
" 'Cause METER and LITER are neater!"

A. Basic Units -

The metric system is based on multiples of 10 while the English system has no such common base. The basic unit of length is the METER which is a little longer than a yard.

The unit of mass in the metric system is the GRAM which is almost 1/30 of an ounce. (While the terms mass and weight are used interchangeably, there is a difference. The mass is the actual amount of matter present in an object and is always constant. The weight depends on the force that gravity exerts on the object and will vary from place to place.)

The unit of volume in the metric system is the LITER which is about a quart.

Besides these basic units, two additional measurements are important in any scientific laboratory. These are the measurement of time based on the SECOND and the measurement of temperature based on the DEGREE in the metric centigrade (Celsius) scale.

It is usually much simpler to abbreviate these units than to write them out so we often use these symbols:

Measurement	Unit	Symbol
length	meter	m
weight	gram	g
volume	liter	L
time	second	sec.
temperature	degree	$(^{\circ})$

B. System of prefixes

In most measurements it is best to choose a unit of measurement of a convenient size. For example, you don't express your age in seconds because the number would be too large, nor in centuries because that would require an inconveniently small fraction. Although the basic unit of length is the METER, it is frequently more convenient to deal with larger or smaller units, especially in lab work. The choice of convenient units of measurement in the metric system is made easy by the system of prefixes listed at the top of page 2.

Prefix		Symbol	Numerical value
kilo...		k.	1,000
	unit		1.0
deci...		d.	0.1
centi...		c.	0.01
milli...		m.	0.001
micro...		μ	0.000001

For example, any of the prefixes chosen may be combined with the basic unit to describe a convenient measurement, such as the following combinations:

Prefix	Unit	Symbol	Value
kilo...	meter	km.	1,000 meters
deci...	meter	dm.	0.1 meters
centi...	meter	cm.	0.01 meters
milli...	meter	mm.	0.001 meters
micro...	meter (micron)	μ	0.000001 meters

or

kilo...	gram	kg.	1,000 grams
deci...	gram	dg.	0.1 grams
centi...	gram	cg.	0.01 grams
milli...	gram	mg.	0.001 grams

C. Conversion units

Because we still use the English system of measurement in much of everyday life we often find it convenient to convert from one system to another. The table below lists a series of these conversion units which you may use for this purpose.

Length

1 in. $\approx$ 2.54 cm.	1 cm. $\approx$ 0.39 in.
1 ft. $\approx$ 30.5 cm.	1 m. $\approx$ 3.28 ft.
1 mi. $\approx$ 1.6 km.	1 km. $\approx$ 0.62 mi.
	1 m $\approx$ 39.37 in.

Weight

1 lb $\approx$ 453.6 g	1 kg $\approx$ 2.2 lb.
1 oz $\approx$ 28.35 g	

Volume

1 oz $\approx$ 29.57 ml.	1 L. $\approx$ 1.06 qt.
1 qt. $\approx$ 0.95 L.	

Temperature (a very handy equation)

$^{\circ}F - 32 = 1.8^{\circ} C$

Notice that these conversions are not spoken of as being EQUAL to each other, but EQUIVALENT. Measurements are equal when they describe the quantity in the same system; measurements are equivalent when quantities are described in different systems. For example:

1 inch is equivalent to ($\cong$) 2.54 centimeters
since inch is an English measure and
centimeter is a metric measure

but

1 inch is equal to (=) 0.08 foot
since both inch and foot are
English measures

and

25.4 millimeters, equals 2.54 centimeters
since both millimeter and centimeter
are metric measures.

All of the measurements we have spoken of so far are definite measurements - they state a specific quantity, a certain amount. The measurements used in biology are usually definite measures such as 20 milliliters of salt solution rather than an indefinite measure such as a spoon full of salt solution. Would a box of salt be a definite or indefinite measure? A five-pound bag of sugar?

LAB STUDY - MEASUREMENT OF LENGTH: NAME__________________

THE CRAYFISH GROUP__________

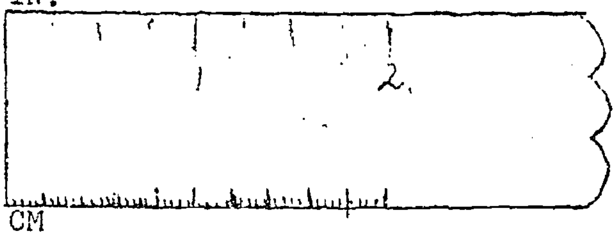
When a microscopist views a specimen through the microscope, not only is he interested in the shape and fine detail, but he is equally concerned with its size. Measurement permits a reliable comparison between the specimen and its parts, and also with other organisms. Thus there must be a uniform scale of measurement so that size values determined by one person can be verified by another.

The unit of measurement most often used by a microscopist is the micron. To the novice biologist, the word "micron" has little meaning. Therefore we must start with a known unit of measurement to learn more about the unfamiliar micron.

DEFINING THE MICRON

The diagram shows a rule that is dually calibrated. The top scale is divided into inches (in.) while the bottom is in centimeters (cm).

IN.



CM

- Study the relationships between the scales. -

1. How many centimeters are there in one inch? ________

2. If there are five centimeters in two inches, then in 6 in. there must be how many centimeters? ________

3. If an object has a diameter of 7½ centimeters this would be equivalent to approximately how many inches? ________

4. Keeping in mind the relationships between the scales, how many inches are equivalent to 20 centimeters? ________

5. A six inch rule would contain how many centimeters? ________

The smaller divisions on the centimeter scale are millimeters. Refer to the drawing again. Each line on the centimeter scale is equal to one millimeter.

6. How many millimeters (mm) are there in one centimeter? ________

7. Therefore how many millimeters equal four (4) centimeters? ________

8. What unit of measurement is larger, centimeter or millimeter? ________

9. Therefore what fraction of a centimeter equals two (2) millimeters? ________

10. Therefore what fraction of a centimeter equals eight (8) millimeters? ________

11. If there are 10 mm equal to one cm., and there are 2½ cm. in one inch, how many millimeters are there in one inch? ________

How many millimeters are there in four (4) inches? ________

13. How many inches are there in 75 mm? ________

Now that you are familiar with the cm. unit as well as the mm. unit, look again at the drawing. Imagine the millimeter unit divided into a thousand parts, one 1000th of a mm, is equal to a micron (μ). Or we can say 1000 microns are equal to one mm.

14. The distance between any two millimeter lines on your drawing is equal to how many microns (μ)? ________

15. How many micron (μ) are there in eight (8) mm? ________

Thus far we have found that: 1 in. equals _____cm
1 cm. equals _____mm
1 mm. equals _____

16. How many micron are there in one centimeter? ________

17. How many micron are there in three (3) cm.? ________

18. How many micron are there in one (1) in.? ________

19. How many micron are there in 6.5 in.? ________

20. What <u>fraction</u> of a cm. equals 15 micron? ________

21. What <u>fraction</u> of an in. equals 15 micron? ________

The metric system of measurement also contains larger units of measurements. These are 10 cm. equals 1 decimeter; 10 dec. equals 1 meter (m.

22. Therefore how many cm. equal one (1) meter? ________

23. How many decimeters equal one centimeter? ________

24. How many microns (μ) equal 1 decimeter? ________

25. How many microns (μ) equal 1 meter? ________

CONCLUSION: ___ mm equals _____ μ <u>10</u> cm. equals ___ decimeters

___ mm equals <u>1</u> cm   ____ deci. equals <u>1</u> meter

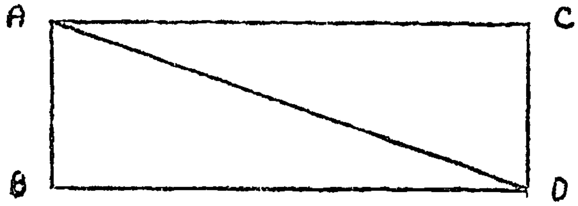
ADDITIONAL PROBLEMS (to be answered on the lines below):

1. ? cm. = 3 in.	6. ? μ = 10.3 in.	11. ? in. = 20 cm.
2. ? cm. = 2 mm.	7. ? μ = 2.5 deci.	12. ? in. = 1 μ
3. ? cm. = 1 μ	8. ? μ = 3.5 cm.	13. ? μ = 2 in.
4. ? mm. = 4 in.	9. ? mm. = 8.5 in.	14. ? deci. = 1 foot
5. ? mm. = 2 μ	10. ? cm. = 5 in.	15. ? in. = 1 m.

1.______	6.______	11.______
2.______	7.______	12.______
3.______	8.______	13.______
4.______	9.______	14.______
5.______	10.______	15.______

UI4 I-C-1: "Measurement of Length"

(3.1) Given the figure below, determine how much longer is line AD than line AB:



(a) 0.45 cm (b) 4.5 cm (c) 4.5 mm (d) 0.40 cm (e) none of these

(3.2) Which of the following pairs of measurements is <u>not</u> of equal value?
(a) 15 cm = 150 mm
(b) 15 cm = 0.15 m
(c) 7.62 cm = 76.2 mm
(d) 7.62 dm = 762 cm
(e) 0.25 ft. = 3 in.

(3.3) Which of the following statements is <u>false</u>?
(a) 0.04 meters is 4 centimeters
(b) 8.69 millimeters is the same as 0.00869 meters
(c) 0.25 centimeters equals 2.5 decimeters
(d) 68.2 millimeters equals 0.682 decimeters
(e) 27 decimeters is as long as 270 centimeters

(3.6) One of the basic units in the metric system is
(a) the millimeter
(b) 4 decimeters
(c) one kilometer
(d) the centimeter
(e) the meter

(3.8) Which of the following pairs of measurements is <u>not</u> equivalent?
(a) 7.62 cm $\approx$ 3 in.
(b) 1 m $\approx$ 100 cm
(c) 1 m $\approx$ 39.37 in.
(d) 13 liters $\approx$ 13.78 qt.
(e) 2.54g $\approx$ 25.4 dg.

(3.9) Which of the following represents an indefinite measure?
(a) a 17 centimeter test tube
(b) a 100 meter dash
(c) 5 centimeters of litmus paper
(d) 4 quarts of sulfuric acid
(e) a length of plastic tubing

LAB ACTIVITY (Basic)
MEASURING WEIGHT IN METRIC UNITS

Usually when you go to the store to buy meats and vegetables the clerk weighs your packages in pounds and ounces. However, since August 18 when the Senate finally approved the Metric Conversion Act of 1972, most items will begin to be weighed using the basic unit of the metric system, the gram, abbreviated g. A gram is a very small weight. In fact, a mouse might weigh 48 grams and a 150 pound man would weigh 68,400 grams.

In this activity you will use a balance scale, 4 numbered objects, a piece of filter paper, a small beaker of sugar, a wood splint, a 50 ml beaker, a 10 ml graduated cylinder, and a large scale.

Before weighing out any material, always be sure your scale is balanced. To do this, move all of the weights on the beams as far left as they will go. Move the smallest weight with the point of a pencil or pen. If your scale is balanced, each weight will show zero on the beam and the indicator will be on the center line. If the indicator is not on center, the scale is not balanced and your teacher will show you how to adjust it.

1. a - d. Place one of your numbered objects on the pan of the scale. Move the largest weight slowly along the beam fitting it carefully into each notch until the beam moves down. Now move it back to the last notch before the over-balance occurred. Notice that this beam measures in hundreds of grams.

   Move the next largest weight along the beam in the same way until the indicator over-balances. Move it back one notch. This beam measures in tens of grams.

   Continue moving each weight in its turn - moving the smallest weight with a pencil point - not your fingers. The position of the smallest weight should make the indicator hit the center point of the scale and stay there. On your answer sheet, write down the number shown on the largest beam (beam #1) first. Directly under it write the number shown on the second beam. Keep the decimal points exactly under each other. Write down the certain numbers shown on the smallest beam and the estimated number between the lines. The total of these four numbers is the weight of the object. Return the four objects to their container when you have finished weighing them all and have your figures checked.

   e. What is the name of the two certain numbers measured on the small beam?

   f. What are these numbers called in the metric system?

   g. What is the name of the estimated number measured on the small beam?

   h. What is the number called in the metric system?

   i. Write the weight measurement your teacher will set for you on the balance.

2. Now weigh out three grams of sugar this way. First, put the filter paper on the pan of the scale. (The weight of the paper will have to be considered because you will be weighing the paper at the same time you are weighing the sugar.) Weigh the paper alone.

   a. How much does the paper weigh?

   b. Add the weight of the paper to the three grams of sugar. Write this total weight on your answer sheet. Set the weights on the scale to indicate this total amount. Pour sugar out of the beaker onto the filter paper a little at a time until the scale just balances. If you pour out too much, use a wood splint to adjust the amount. When your measurement is as accurate as possible, have your work checked and the box signed.

   c. Now weigh out 5.4 g of sugar on the filter paper. What is the total amount shown on the scale? Have your measurement checked.

   d. Using a 50 ml beaker and a graduated cylinder, measure the weight of 10 ml of water.

   e. Figure out how much 1 ml of water weighs. Show your arithmetic on your answer sheet, putting a box around your answer.

3. a. Using the floor scale in the lab, measure your own body weight as accurately as possible in pounds and record it on your answer sheet.

   b. How many kilograms do you weigh?

QUIZ I-C-2: Measurement of Weight

(3.2) The following pairs of values are not all of equal value. Which pair is unequal?

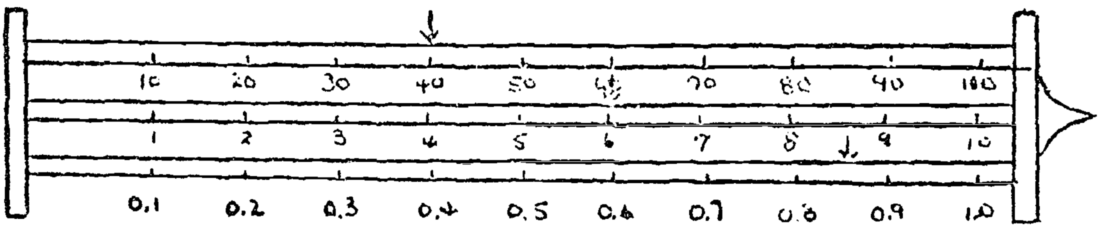
(a) 0.5 kg = 500 g
(b) 1 g = 0.001 mg
(c) 48 dg = 480 cg
(d) 0.25 kg = 25,000 cg
(e) 1,000,000 mg = 1 kg

(3.3) Which of these metric prefixes is incorrectly attached to a numerical value?

(a) 1,000 grams is a kilogram of NaCl
(b) One hundredth of a gram equals 1 milligram
(c) 1 g equals 1000 milligrams
(d) One decigram weighs the same as 0.1 gram
(e) One mg is the same weight as $\frac{1}{1000}$ gram

(3.4) Below is a drawing of the triple beams of a balance scale. The most accurate amount of glucose being weighed is

(a) 406.80 g.
(b) 406.8 g.
(c) 46.8 g.
(d) 406.85 g.
(e) 46.85 g.



(3.6) One of the fundamental units used in the metric system is found in which of these measurements?

(a) one gram of manganese dioxide
(b) four milliliters of hydrogen peroxide
(c) one test tube of chlorophyll extract
(d) 30 centigrams of formalin
(e) 1 mile

(3.8) Which of these trades would not be of equivalent value?

(a) 1 pound of wax for 2.2 kilograms of wax
(b) 1 pound of NaOH for 22 kg. of NaOH
(c) 2.2 lbs. of dextrose for 1 kg. of dextrose
(d) 2,000 kg. of sand for 2,000 lbs. (1 ton) of sand
(e) 15 lbs. of nails for 6 kg. of nails.

(3.9) You would not know how much to pay for one of these items. Which one is it?

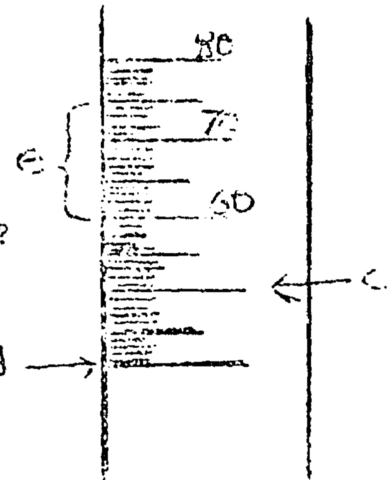
(a) one box of microscope slides at 4.00 a pound
(b) one kilogram of mercury at .25 per gram
(c) 5 liters of ether at 2.75 per liter
(d) 1 dozen centigrade thermometers at 3.00 each
(e) 7 mg. of aspirin at 10¢ per gram

LAB ACTIVITY -
MEASURING VOLUME IN METRIC UNITS

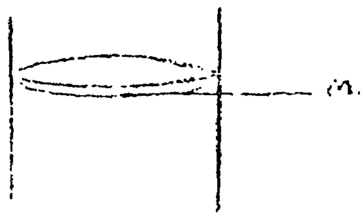
Each of us at one time or another needs to use an instrument to measure an amount of liquid. Measuring volume in metric units is based on the number 10 and is easier to use than the English system. In this activity you will use 2 beakers, 2 graduated cylinders of different sizes, and a dropping pipette. To prevent breaking the graduated cylinders, always lay them on the side when not in use.

1. Which of these items of equipment would be easiest to use to measure an exact amount of water?

2. In a graduated cylinder, the amount of a liquid often will be measured in milliliters, abbreviated ml. The milliliters on your cylinder are indicated by the longest numbered lines. Look at the larger cylinder.

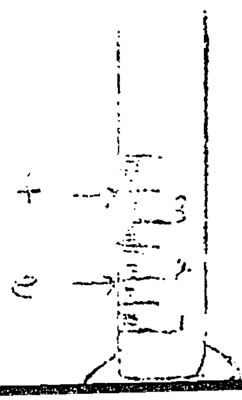


   a. What total number of milliliters of a liquid can it measure accurately?
   b. The space between the numbered 70 and 80 represent what volume of liquid?
   c. If the cylinder were filled to the arrow marked c, how much liquid would it contain?
   d. If the liquid came to the arrow d, how much would there be?
   e. How much volume is represented by the bracket e?
   f. Go to the sink and bring a beaker half full of water back to your table. Pour any amount of this water into the cylinder and place the cylinder on the table. With your eyes on the level of the water, notice that the top of the water seems to form a double curved surface when you look through the glass. The bottom of this curved surface is called the meniscus and it should be used when you are measuring the number of milliliters of a liquid. How many milliliters have you poured into the cylinder?



   g. Would you guess that 100 milliliters of water is more or less than a cup of water? Find out.
   h. Measure: 100 ml. of water = how many cups of water?

3. Loot at the smaller graduated cylinder.
   a. How many milliliters of liquid can it measure accurately?
   b. The space between the numbers 7 and 8 represent what volume of liquid?
   c. Into how many smaller units is the space between 7 and 8 divided?
   d. What should each of these smaller divisions be called? Show this amount on your answer sheet as a fraction and also as a decimal.
   e. The arrow e represents what volume?
   f. If the cylinder were filled to f, how much liquid would there be?



g. Using your pipette and the dry cylinder, accurately measure the number of drops of water required to occupy a volume of one milliliter. Watch the meniscus carefully. Write the number of drops you count on your answer sheet. You should make this count 3 or 4 times to get the most accurate count.

4. Your small cylinder accurately measures 10 ml. which is often called a <u>centiliter</u>. What is the abbreviation for centiliter?

5. How many centiliters of water could you pour into your 100 ml. graduated cylinder?

6. One of your beakers is labeled 1000 ml. This is sometimes called one liter. About how much is a liter equivalent to in English units?

7. How many times would one liter beaker of water fill your larger graduated cylinder?

8. a. Notice that on each beaker a line has been drawn in grease pencil. Fill each beaker to the line with water. Pour the liquid from beaker A into the large graduated cylinder. How many milliliters of water did beaker A contain?

   b. Measure the water in Beaker B in milliliters.

   c. How many <u>liters</u> of water did beaker A contain?

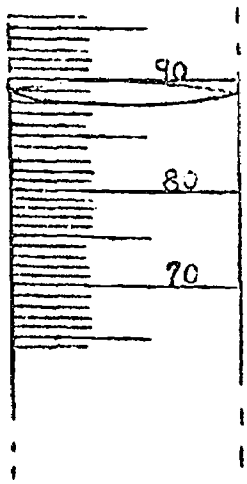
   d. How many <u>liters</u> of water did beaker B contain?

QUIZ I-C-3: "Measurement of Volume"

(3.2) Most of the pairs of measurements below are of unequal value. Which of the pairs is equal:
(a) 135 liters equals 13,500 milliliters
(b) 10 centiliters is equal to 1/10 of a liter
(c) 2.35 deciliters equals 23.5 liters
(d) 7.4 liters equals 7400 kiloliters
(e) 450 milliliters equals 4500 deciliters

(3.3) Which of the following statements is true?
(a) 1 kiloliter = 0.001 liter
(b) $\frac{1}{1000}$ of a kiloliter is 10 liters
(c) 0.001 of a kiloliter is 100 liters
(d) 0.001 kl = 10 liters
(e) $\frac{1}{1000}$ of a liter is the same as 1 milliliter

(3.5) In an experiment, a student was asked to bubble carbon dioxide gas through 84 milliliters of phenolphthalein solution in a flask. His measurement in a graduated cylinder mad him



(a) wish he took art instead of biology
(b) lack 4 ml. pouring enough solution
(c) use just the right amount
(d) use 4 ml. too much
(e) none of the above

(3.6) One of the basic measurements in the metric system is
(a) the liter (b) the milliliter (c) 10 centiliters (d) 4
(d) 4 liters (e) the kilogram

(3.8) In a drug store, the labels have been changed from English units to metric units. From the list below, choose the product which has been incorrectly labeled:
(a) 1 oz. or 28 g. mercurochrome
(b) 9 oz. or 252 g air freshener
(c) 2.2 lbs. or 1 kg. of Lysol spray
(d) 1 gal. or 3.7 liters of rubbing alcohol
(e) 12 kg. or 6 lbs. of bird seed

(3.9) Which of the following measures would you be least certain about?
(a) four liters of pond water
(b) a bottle of sea water
(c) ten cubic centimeters of Wright's blood stain
(d) 4.5 cc of methyl alcohol
(e) 0.7 ml. of physiological saline solution.

LAB ACTIVITY -
USE OF THE BUNSEN BURNER
AND THE THERMOMETER

DO NOT WRITE
ON THIS PAPER!!!

Introduction

A Bunsen burner is a specialized apparatus used to burn natural gas. It is used as a convenient source of efficient heat in the laboratory. It is commonly used to impart heat to liquids and solids. The amount of heat transferred to a substance can be accurately measured by using a thermometer. Both the Bunsen burner and the thermometer are devices that require safe and proper handling. Keep this point in mind as you proceed to do this lab study.

Purpose

To enable the student to use the thermometer and bunsen burner for data compilation as well as for the development of good habits for their use.

Materials (for teams of 2)

- Bunsen burner
- Thermometer
- Beaker (400 ml)
- Stirring rod
- Ruler
- Water
- Ringstand and iron ring
- Wire screen
- Timer with sweep second hand
- Beaker tongs

Procedure A

Place the Bunsen burner on the ring stand base. Adjust the iron ring so that it is roughly 8 cm above the barrel of the burner.

Fill the beaker with water to the 300 ml line. Be sure to check the water volume at eye level. Place the beaker of water on the wire screen of the iron ring.

Place the thermometer in the water and after 1 minute record the water temperature on the answer sheet. (This is starting temperature.)

Carefully light the Bunsen burner and heat the water while stirring with a glass rod. After 1 minute record the new temperature on your data sheet. Repeat this step until 6 minutes of time have passed. Record all readings on the data chart. Be sure to turn off burner when finished.

When you have compiled all data begin to clean up your work materials. Use beaker tongs to empty hot water in the sink. Dry all wet apparatus with paper towel. Place the apparatus on the tray and dispose of all waste paper.

Procedure B

Study the data chart and decide how you will plot the statistical data on a line graph. When you are sure of your graph construction use a ruler to draw all lines. Number and label each axis and use an appropriate title. Hand in your answer sheet when you have completed the data chart, graph and questions.

ANSWER SHEET:
USE OF THE BUNSEN BURNER
AND THE THERMOMETER

NAME________________________

GROUP__________

Directions: Record all data from Procedure A in data chart below.

Time in Minutes	Temperature in Degrees C
	(starting temp.)

Directions: After reading Procedure B, construct your graph below.

Directions: Answer the following questions carefully.

____1. How many degrees are marked on your Celsius thermometer? (a) 100 (b) 130 (c) 212 (d) 90

____2. As the heating time increased the temperature readings (a) decreased (b) stayed the same (c) increased (d) decreased then increased.

____3. If heated beyond 6 minutes the temperature would (a) continue to increase (b) decrease (c) remain the same (d) lower, then stay the same.

____4. Your graph line will be interpreted as (a) variable, (b) an inverse relationship, (c) a constant, (d) a direct relationship.

____5. Water at a 10° C reading placed in a room where the temperature is 25° C will (a) change temperature (b) increase temperature (c) decrease in temperature (d) remain the same.

____6. A Bunsen burner flame is orange. To produce a blue flame one would (a) reduce the gas (b) increase the air (c) decrease the air (d) increase the gas.

LAB ACTIVITY -
USE OF THE BUNSEN BURNER
AND THE THERMOMETER

DO NOT WRITE
ON THIS ACTIVITY!

Background

In many of your upcoming lab studies you will be expected to make accurate measurements relative to heat gain or heat loss. Such measurements cannot be done by touch and then simply state that an object is hot or cold. For scientific work it is necessary to indicate the degree of heat present which can best be determined by use of a thermometer. Most materials expand when heated and contract when cooled. The thermometer is based on the nearly linear expansion and contraction of liquid mercury with changing temperature.

Mercury thermometers for scientific use are calibrated in the Celsius temperature scale. Such a thermometer has two fixed points: the normal freezing point of water, 0° C and the normal boiling point of water, 100° C. The interval between the freezing point and the boiling point is divided into 100 equal parts, each representing a temperature change of 1° C. The same scale divisions may be extended beyond the two fixed points to provide for readings below 0° and above 100°.

A Bunsen burner is a specialized devide that is used in the lab and when properly adjusted produces temperatures above 1000° C. It is composed of a tube-like barrel attached to a circular base. There will also be two inlets (one for air and one for natural gas) built into the burners' construction. These inlets will allow you to make adjustments so that the gas-air mixture will produce the hottest flame. The air inlet will be a collar with holes in it which fits over the barrel. One end of a rubber tube will be attached to the gas inlet and the other end will connect to the gas source.

Purpose

To become acquainted with both the Bunsen burner and the thermometer as well as the save, effective use of each.

Introduction

The best way to become familiar with chemical apparatus is to actually handle the pieces in the laboratory. In this lab activity you will learn to adjust the Bunsen burner, assemble an iron ring-ring stand, measure a volume of water and make accurate readings, timings and recordings about a thermometer.

Materials

- Ringstand & iron ring
- Wire screen
- Beaker (400 ml.)
- Thermometer
- Stirring rod
- Chalk
- Bunsen burner
- Timer (sweep second hand)
- Beaker tongs
- Ruler
- Masking tape

Procedure A

1. Disassemble a Bunsen burner into its component parts. On the answer sheet, make identifications of its parts and note its function. Reassemble the burner and sketch it on your answer sheet. Label each part.
2. Inspect a Celsius thermometer. Make an accurate drawing of the device on your answer sheet.

Procedure B

1. Place a Bunsen burner on the base of a ringstand. Place an iron ring on the ring stand so that the distance between the top of the burner and ring is 2.5 cm. Using masking tape on the vertical rod of the ringstand, mark positions 5, 7.5, and 9 cm. above the top of the Bunsen burner. Use a pencil and a ruler.
2. Fill the beaker with cold water to the 300 ml mark and carefully sight the meniscus at eye level. Find the temperature of the water and record it on the data chart of your answer sheet.
3. Take the Bunsen burner aside. Adjust the air supply so that the air holes are about two-thirds open. Place a lighted match over the barrel. Turn on the gas to give roughly ½ maximum supply. Keep your clothes and face away from the barrel. Adjust the air supply if necessary to make a flame with an inner blue cone clearly defined. The flame should not make a roaring noise. Once adjusted, the flame should <u>not be changed</u> throughout this activity.
4. Place a wire screen on the iron ring and place the beaker (with water) centered on the screen. <u>NO</u> water should be on the outside of the beaker! Prepare to measure time. At a convenient starting time, place the lighted burner directly beneath the center of the beaker of water. Stir the water gently with a stirring rod. Read and record the temperature of the water every minute for 6 minutes. Mark the position of the burner on the base of the ringstand with chalk. Remove the burner. Make a graph of the result, plotting temperature on one axis and time intervals on the other axis.
5. Remove the hot water from the beaker carefully by using beaker tongs. Avoid touching hot water, glass or metal. Rinse the beaker with cold water and douse the hardware with likewise. Wipe dry! When all labware is back to room temperature change the distance of the iron ring to 5 cm above the barrel.
6. Repeat steps 2, 3, 4, and 5 for iron ring heights of 7.5 & 9 cm.
7. Record all data in ruled tables provided and make a graph of each result.

Procedure C

Answer all questions listed below on your answer sheet.

1. When the air inlets of a Bunsen burner are closed, which of the following is likely to happen? (a) flame will go out, (b) flame will turn orange, (c) the burner will explode, (d) flame becomes all blue.
2. To be certain that the gas source is turned off you should (a) put a finger over the barrel, (b) parallel the valve to the gas jet, (c) pull off the rubber tubing, (d) cross the valve over the gas jet.
3. For accuracy in measuring the temperature of water the thermometer should be (a) kept in the water, (b) raised to eye level in the air, (c) insulated, (d) placed under a dissecting microscope.
4. You have seen that an increase in time will result in an increased temperature of heated water. This is a good example of (a) a theory (b) inverse relationship, (c) direct relationship, (d) a variable.
5. At what distance between the iron ring and bunsen top does the water heat at the fastest rate?
   (a) 2.5 cm (b) 5 cm (c) 7.5 cm (d) 9 cm
6. Relative to heating water, what is the meaning of the line on the graph that shows the least slope?
   (a) fastest rate of heating (b) no heat change
   (c) there is no significance (d) slowest rate of heating.

ANSWER SHEET - LAB ACTIVITY
USE OF THE BUNSEN BURNER
AND THE THERMOMETER

NAME ____________________

GROUP __________

Procedure A

1. Bunsen burner

PARTS	FUNCTION

Bunsen Burner Sketch

2. Thermometer Sketch (sketch long axis E-W)

Procedure B

DATA CHART

2.5 cm		5 cm		7.5 cm		9 cm	
Time	Temperature	Time	Temperature	Time	Temperature	Time	Temperature

NOTE: Place all graphs on the back of the answer sheet.

Procedure C Place the most correct letter answer alongside the number.

1. ________ 4. ________

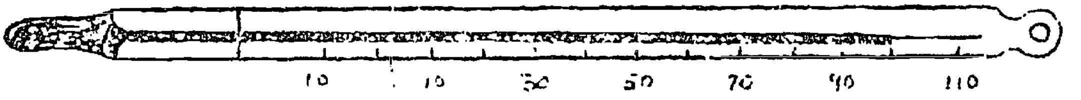
2. ________ 5. ________

3. ________ 6. ________

QUIZ I-C-4: "The Thermometer"

(3.7) Examine the drawing of the centigrade thermometer below. The column of mercury indicates which of the following:

(a) freezing point of water
(b) normal body temperature
(c) average room temperature
(d) boiling point of water
(e) surface temperature of the sun



(3.8) If your centigrade temperature were measured to be 39°, would you have a fever?
With which Fahrenheit temperature is it equivalent?
(a) 96° (b) 98° (c) 100° (d) 102° (e) 104°

(3.9) Which of these statements is most exact in its measurement?

(a) A Bunsen burner blue flame is very hot.

(b) The yellow Bunsen flame is not hot enough to burn the gas fuel completely.

(c) A blue Bunsen flame can melt copper at a temperature greater than 1,000° C.

(d) Ice water is very cold.

(e) The addition of salt to a beaker of ice water would decrease the freezing point.

NAME ____________________

GROUP ____________

AN EXERCISE IN MICROMETRY

1. MICROMETRY is the determination of the sizes of objects and specimens seen with the aid of the m________scope.

(The correct answers and responses are to the left and below each frame. When your answer is shown to be correct, continue on to the next frame.)

---

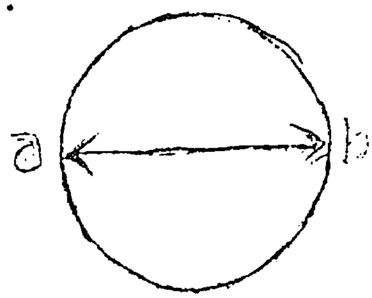
2. There are several kinds of measuring devices by which one can determine the sizes of ________s seen under the microscope.

---

3. If the dimensions of the microscopic field can be determined, then the field itself can be used as a measuring device to approximate the ____________of objects under the microscope.

---

4. The field of vision in the ordinary light microscope has the shape of a circle, as shown below. The distance from a to b is the __________of the circle.



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5. If the diameter of the field is known, then one can approximate the ________of objects visible in the microscopic ____________.

---

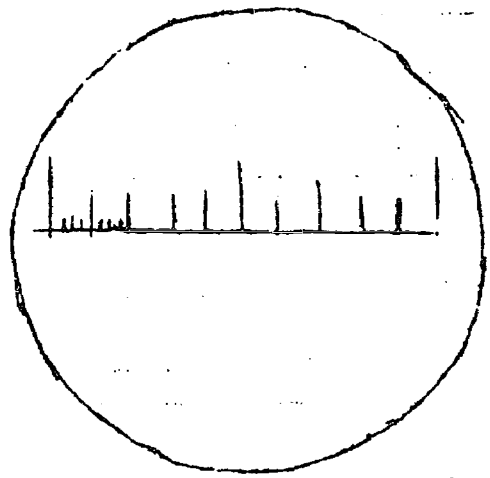
6. Devices used to determine the dimensions of objects seen under the microscope are called m__________ometers.

---

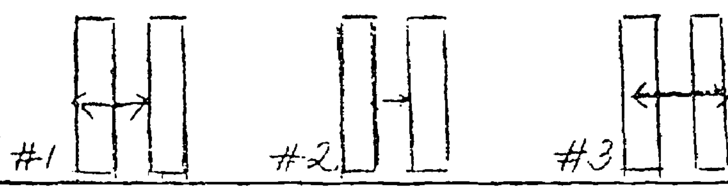
7. The ending "meter" is used in everyday language. We call devices that measure temperature thermo________, that measure atmospheric pressure baro________, and that measure speed, speedo____________.

8. Devices that are used for measuring objects under the microscope are called ____________.

9. The sketch below indicates the appearance on the 1 mm. stage micrometer as seen under the microscope. The lines on the <u>right</u> are ________ mm. apart and the smaller lines on the <u>left</u> show distances of ___________ mm.



10. With the stage micrometer in use with high power objectives, care must be taken in using the engraved lines as reference points. In the sketches below, the method which is the most accurate way of measuring 0.1 mm is indicated by sketch # _________.

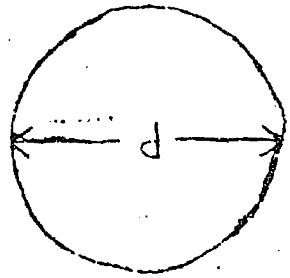


11. Sketch #1 is the most accurate method of finding the correct distance, since it takes into account the thickness of the engraved ____________.

12. The thickness of the engraved lines becomes more important with ________er powers of objectives.

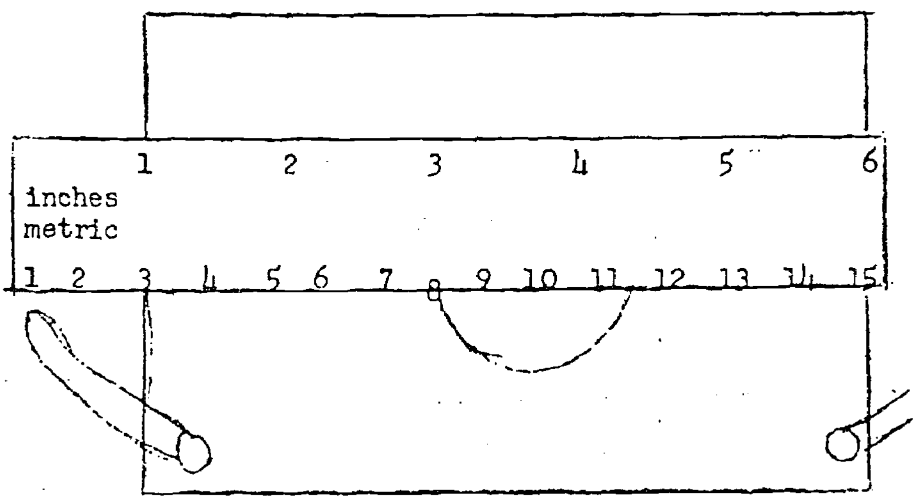
13. In our work in general biology, it will not be necessary to make many precise measurements under the microscope. By estimating

the diameter of the microscopic field, as shown below, one can use this diameter as an approximate, but accurate, measuring device or __________.

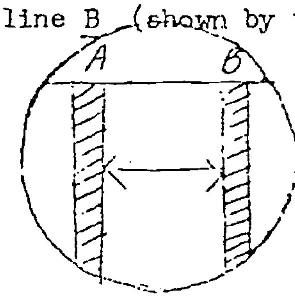


14. To make a rough estimate of the diameter of the low power field, swing the low power objective into place. The low power objective is the ________er of the two objectives.

15. Secure good reflected light from above, and place your ruler about half way across the hole in the stage with the metric scale, which is the ________(upper/lower) scale, across the diameter of the hole.



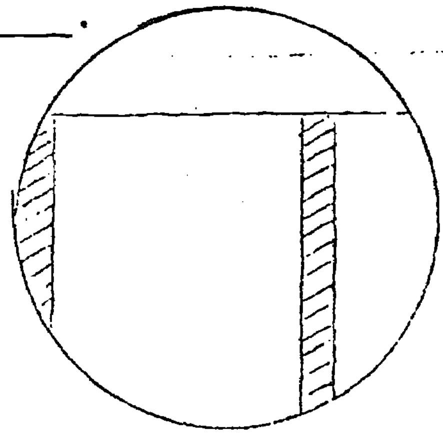
16. Observation under the microscope should reveal an appearance similar to the sketch below. Focus and adjust until two lines appear in the field. We know that the distance from the right hand edge of line A to the right hand edge of line B (shown by the line with arrows) is reasonably close to __________ mm.



17. Is it possible to see three lines in one field? ________

18. Since you can see two lines in the field, the diameter must be at least ________ mm. But since three lines cannot be seen, the diameter of the field must be less than ________ mm.

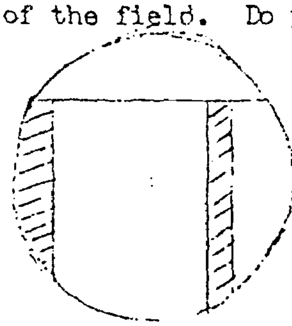
19. Now move the ruler so that the left side of one line just touches the extreme left (9 o'clock) side of the field. Observe the right hand line. Is it nearer to the right (3 o'clock) side than to the middle of the field? ________.



20. Since the right hand line was nearer the right (3 o'clock) edge than to the center of the field, the diameter must, therefore, be (greater/less) than 1.5 mm? ________________

21. Since two lines are visible in the field, the diameter must be at least ________ mm. Therefore, the diameter of the low power field must lie between ______ mm and ________ mm.

22. The diameter of the low power field is between 1.0 mm and 1.5mm. Now judge the distance between the left hand edge of the right hand line and the right (3 o'clock) edge of the field. Do you estimate this distance to be greater than 0.3 mm but less than 0.5 mm? ____________?



23. The diameter of the low power field, then, lies between 1.3 mm and 1.5 mm. Because this is an approximation, a value midway between 1.3 and 1.5 is convenient. It is estimated that the diameter of the low power field is ________ mm.

---

24. Before changing the value to microns, remember that there are ________ microns in 1 mm.

---

25. To change 1.4 mm into microns, multiply 1.4 by ________ to get ________ microns.

---

26. Record this information on the inside cover of your lab manual: "The diameter of the low power field of microscope # ________ is ________ mm or ________ microns."

---

27. To determine the diameter of the high power field,
(a) Get a dark human head hair and cut it to a length of 1 cm.
(b) Mount the hair on a microscope slide;
(c) Add a drop or two of tap water;
(d) Cover with a cover glass.

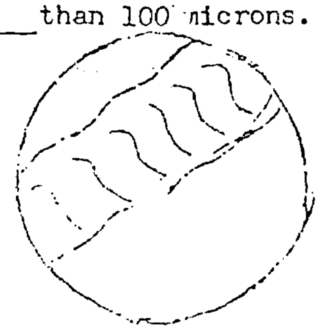
Since about 10 hairs can be lined up in the space of 1 mm, one hair would have a width (or diameter) of about ________ microns.

---

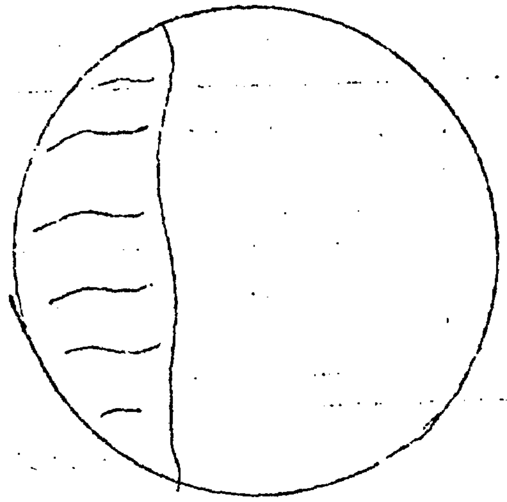
28. After focusing the hair under the low power of the microscope, swing the high power objective into place. The high power is the ________er of the two objectives on the revolving nose piece.

---

29. Under the high power of the microscope the hair should appear as shown below. If the hair is 100 microns in width, the diameter of the field is (greater/less) ________ than 100 microns.



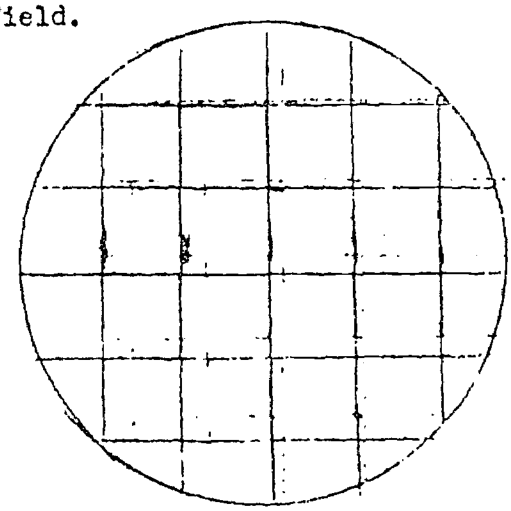
30. Move the slide so that the left edge of the hair is at the extreme left (9 o'clock) of the field, as shown below. By moving the slide, estimate how many times the hair will fit into the field. __________ times.



31. If the hair can be placed approximately three times across the field, and the hair is 100 microns in width, the diameter of the high power field is approximately ________ microns.

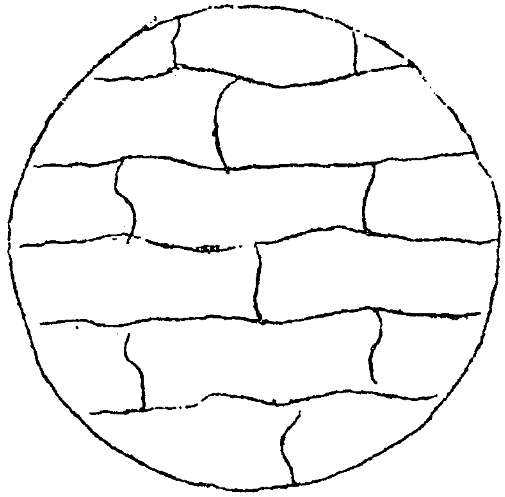
PROBLEMS AND PRACTICAL USE

32. The sketch below represents the field using the low power of the microscope. The diameter of the low power field is ________ microns (refer to frame #26). There are about _______ squares across the diameter of this field.

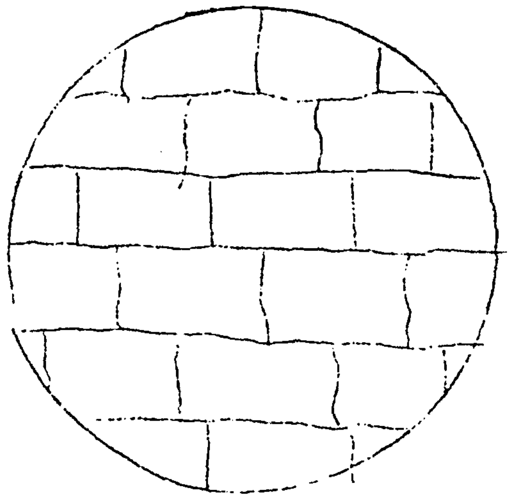


33. If the diameter of the field is 1400 microns and there are 6 squares across the diameter of the field, each square must be about ________ microns on a side.

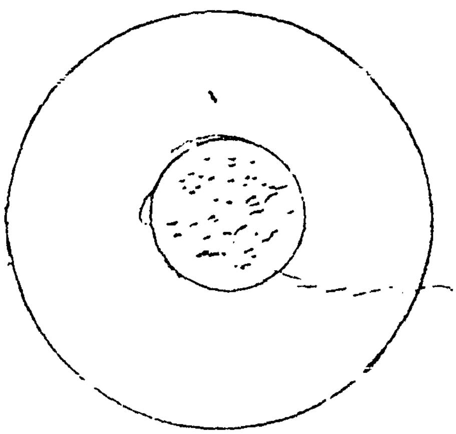
34. What is the approximate length of the cells shown in the field below as seen under the low power of the microscope? __________?



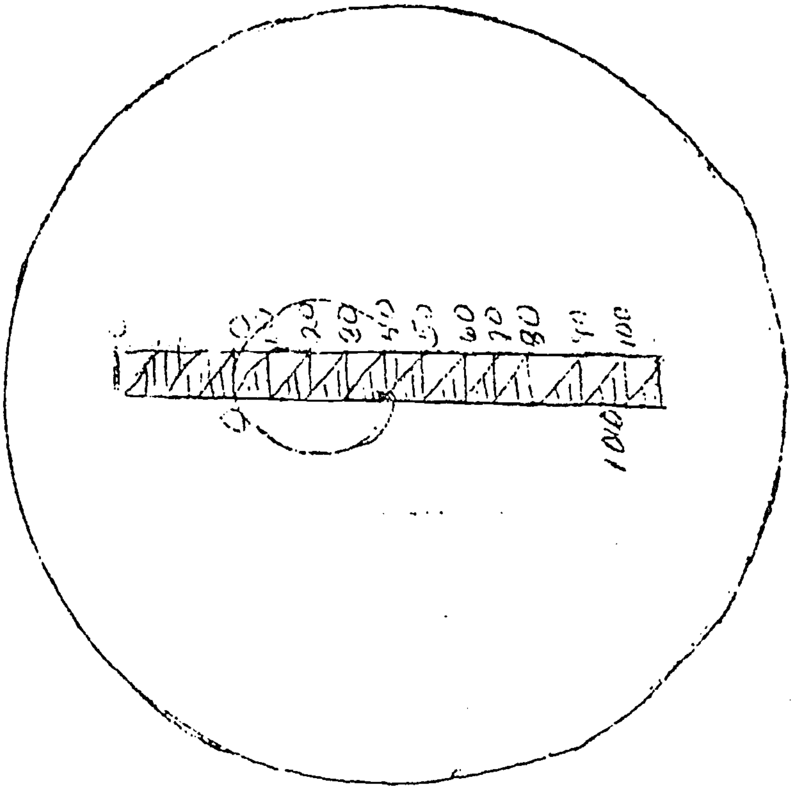
35. The diameter of the HIGH power field is _____microns. The approximate WIDTHS of the cells shown below under high power are ________.



36. What is the approximate size of the object seen in the field below under the HIGH power of the microscope? _________?



37. The actual diameter of the diatom shell shown in the sketch is __________?



38. Turn in your answers to your instructor. You may then take the final exam.

"Measurement Under The Microscope"-(Set 91)
ANSWER SHEET

NAME ______________________
SHEET ____________

Directions: Place all answers on the answer sheet provided. Make no marks in the program booklet.

I. Calibrating-Planaria

A. Slide calibration= ______________ micrometer spaces= ____________ mm.

B. Green Planaria= ______________ micrometer spaces= ____________ mm.

C. Red Planaria= ______________ micrometer spaces= ____________ mm.

D. Shorter or longer (circle one) by ____________ mm.

E. Green Planaria length ______________.

F. Red Planaria length ______________.

II. Average: Onion Root Tip

A. ______________ micrometer unit= ______________ mm.

B. ______________ mm average length.

C. ______________ mm average width.

III. Volume: Starfish Egg

A. ______________ micrometer units= ______________ mm.

B. ______________ mm (Egg diameter)

C. ______________ mm (Nucleus diameter)

D. ______________ mm (Nucleolus diameter)

E. ______________ Volume ratio.

IV. Volume-Spirogyra

A. ______________ micrometer units= ______________ mm.

B. ______________ mm. (Average length)

C. ______________ mm. (Average width)

D. ______________ (mm^3) (volume)

V. Counting-Trypanosoma Gambiense Smear

A. ______________ Trypanosoma count

B. ______________ Red Corpuscle count

C. ______________ Ratio of Trypanosoma to Red Corpuscle.

D. ____________ micrometer units = ____________ mm.

E. ____________ mm. (Trypanosoma size)

F. ____________ mm (Red Corpuscle size)

VI. Thickness-Taste Buds

A. ____________ micrometer units = ____________ mm.

B. ____________ mm (Epithelium thickness -thick section)

C. ____________ mm (Epithelium thickness-thin section)

D. ____________ mm (Length of canal)

VII. Growth-48 hour Chick Embryo

A. ____________ micrometer units= ____________ mm.

B. ____________ mm (Ear height) ____________ mm (Ear Width)

C. ____________ mm (Eye height) ____________ mm (Eye Width)

D. ____________ mm (Heart height) ____________ mm (Heart Width)

E. ____________ mm (Arteries height) ____________ mm (Arteries Width)

F. ____________ mm (Brain height) ____________ mm (Brain Width)

VIII. Growth-96 hr Chick Embryo

A. ____________ micrometer units= ____________ mm.

B. ____________ mm Ear height ____________ mm Ear width

C. ____________ mm Eye height ____________ mm Eye width

D. ____________ mm Heart height ____________ mm Heart width

E. ____________ mm Arteries height ____________ mm Arteries width

F. ____________ mm Brain height ____________ mm Brain width

G. Yes or No (Circle Answer)

NAME______________

GROUP__________

LABORATORY STUDY - THE VOLUMETER

A. Introduction: Forming a Hypothesis

This laboratory study is designed to tie observation and measurement to experimentation. There are many scientific methods, each appropriate to a particular field of search. There are many methods and techniques in music composition, literature and art. Science is somewhat of a creative act and how the scientist operates depends on the conditions of his particular problem. In your laboratory work, I shall try to present a variety of problems involving a variety of methods of solving them. As a result of this variety you should begin to learn how biologists and scientists work.

Observe the contents of two large test tubes on the demonstration table. One of these flasks has been chilled, while the other has been left to stand at room temperature.

(1) What visible difference is there between the two flasks?

(2) Why are there more gas bubbles in the warmer flask?

(3) If you were to test your hypothesis by an experiment, how would you do it?

Because I could not predict all of the hypotheses and testing procedures that you might think of, I have selected one hypothesis and a testing procedure for it as an illustration.

Assumption: gas bubbles are caused by an activity going on in the warmer flask but not in the colder one.

Testable Hypothesis: If the activity responsible for the gas bubbles is affected by temperature, then a change in temperature will produce a change in activity.

An even more fruitful hypothesis could result from another fact and an additional assumption.

The Fact: Both flasks contain mixtures of sugar and living yeast.

The Assumption: The gas is being produced by the yeast.

The New Hypothesis: If the rate at which yeast cells produce gas is affected by temperature, then a change in temperature would change the rate of gas production.

(4) Can you think of some ways you might go about testing this hypothesis?

The best experimental testing procedure for this type of problem is one that is quantitative. The temperature can be controlled with varying degrees of precision. Then, what is a good method of determining the gas production quantitatively? We might count bubbles but they could differ in size. As you know, gases exert pressure so that if we can measure the pressure differences in the flasks as a result of various temperatures, we could state the quantitative difference in gas production at each of the chosen temperatures.

To measure gas pressures, a good instrument is the volumeter. Examine the drawing and construct a volumeter (vol-ew-meeter) apparatus with the materials provided. A simple volumeter consists of a length of transparent tubing containing a drop of colored liquid. The tubing is connected at one end to a closed container. A syringe regulates the position of the colored liquid in the tubing. When pressures on both sides of the colored liquid are equal, the liquid remains in the same position. When the pressure on one side of the liquid is greater than on the other side, the liquid will move in the direction of lesser pressure.

Push the syringe plunger all the way down to the zero mark. Place a drop of the colored liquid into the open end of the tubing. Pull the syringe plunger gently until the liquid reaches the zero marking on the ruled tubing. The mark registered on the syringe after the liquid reaches the zero point is the volume of the measured tubing. Record the volume. ____________

While the liquid is at the zero end of the tubing, place your hand around the test tube. Hold the tube firmly in your hand for about one minute.

(5) Explain why the liquid moved.

(6) If the test tube contained a sugar, water and yeast mixture what would happen to the liquid in the volumeter tubing?

(7) What do you think would happen to the liquid in the tubing if the test tube contained a sugar solution only?

B. Testing the Hypothesis

Materials

Volumeter apparatus	Ice cubes	Hot water
Yeast-sugar mixture	Sugar solution	Thermometer

Procedure

Room Temperature Test

Record the room temperature in Centigrade degrees ____________

Prepare a water bath that nearly matches room temperature. The water bath is used to keep the solutions at this same temperature during the measurements. Read and record the temperature of the water bath from time to time. If the temperature varies by as much as one degree, add ice or hot water to maintain the

B. Testing the Hypothesis (Continued)

original temperature.

Set up the apparatus as pictured in the drawing. Remove the syringe and stopper while you are setting up the remainder of the apparatus. Fill one test tube to about the three-quarter level with yeast-sugar mixture, and another test tube to the same level with sugar solution. Before replacing the syringe, place the test tubes in the water bath. Allow the apparatus to stand for about two minutes to equalize the temperature. Be sure the stoppers are tight. Replace the syringe only when all materials are prepared and you are ready to measure the amount of gas produced.

Insert the syringes in the stoppers of both tubes and check to see whether the liquid in the tubing is moving in the expected direction. If it is not, remove the syringe and check for possible leaks in the apparatus.

When the liquid in the tubing is moving as expected, position the syringe plunger so that the liquid in the tubing is at the starting point. Start recording the time and volumeter readings in a table. Continue recording the readings at one minute intervals for 10 minutes. If the production of gas is very rapid, it may be necessary to take readings at shorter intervals. Also, it may be necessary to remove the syringe and stop the measurement to prevent the liquid from being pushed completely out of the tubing.

Cold test
After you have a good measurement of the rate of gas production at room temperature, adjust the syringe plunger so the liquid is near the starting position. Remove the syringes from the stoppers and place the test tubes in a water bath 10° cooler than room temperature. Repeat steps 3 and 4 in the procedure above and determine the rate of gas production at the lower temperature.

Warm test
Repeat the procedure of the room temperature test substituting a warm bath 10° higher than room temperature.

(8) Prepare a line graph with time in minutes on the horizontal and volumeter reading in millimeters on the vertical. Put the data from all three tests on the same graph using different-colored pencils for the three temperatures. Use separate sheet.

(9) Was the experiment in part B quantitative or qualitative? Why?

(10) From which solution was the gas produced, the sugar solution or the sugar and yeast mixture? ______________________

(11) What was the purpose of the solution that produced no gas?

(12) Do the results of this experiment confirm the hypothesis you formed in part A? Why?

(13) Make a prediction concerning the production of gas at an even higher temperature, for example, at 20° above room temperature. Explain the reasons for your prediction.

(14) What hypothesis can you form from the results of this experiment?

Name ______________________ Section ____________

ELECTROLYSIS OF WATER

INTRODUCTION

Energy is important in all biochemical reactions. Energy of some kind is involved each time a chemical compound is formed, broken down, or changed in some way. The electrolysis of water, the splitting of water into hydrogen and oxygen is energized by an electric current.

Water, the most abundant compound in living material, making up 80% of protoplasm is essential for chemical reactions fundamental to life.

DISCUSSION:

1. Try to list as many observations as you can as you watch the demonstration.

    1.

    2.

    3.

    4.

    5.

    6.

    7.

    8.

    9.

    10.

2. Notice the bubbles of gas coming from the electrodes.
    A. Are the bubbles the same size in both tubes? ____________

    B. Why do they rise to the surface? ______________________________

    C. Do the bubbles come from any particular part of the electrodes? ____________

3. Does the gas appear to be released from each electrode at a constant rate? _______

4. What measurements could be made to confirm your answer? ____________________

____.

5. If you were to graph these measurements, what two variables would you plot on the graph?

6. You have probably noticed by now that the water level is not the same in both tubes.
    A. What hypotheses can you give to account for the difference in water?

    1.

2.

3.

4.

7. What is the ratio between the volumes of gas in the two tubes?

8. Does the splitting of water into its parts require energy?

9. What evidence is there that the two tubes may contain different gases?

A.

B.

10. Record what happens when a lighted splint is placed near the mouth of test tube #1.

11. How do you account for the formation at the mouth of the test tube?

12. What happens when a glowing splint is introduced into test tube #2?

13. What is the gas?

14. Write the formula for water. Explain the meaning of this formula.

15. Draw a diagram of a molecule of water.

16. What charge of electricity does hydrogen have?

17. What charge of electricity does oxygen have?

18. When water is split during photosynthesis what happens to the oxygen?

19. What happens to the hydrogen of water in photosynthesis?

20. By use of equations show:

A. The splitting of water

B. The burning of hydrogen

LAB ACTIVITY - REMEDIAL #1 BIOGENESIS AND ABIOGENESIS

Purpose

To compare the theories of spontaneous generation and biogenesis. This activity will enable you to work with one of the scientific methods that could lead to new interpretations.

Materials

Prepared cultures of nutrient broth (18 x 150 mm test tubes)
Test tube rack
10 ml graduated cylinder #2 solid rubber stoppers
S-shaped glass tube #2 one-holed stoppers

Procedure

Several days ago nutrient broth was placed in a group of different test tubes. Each tube was labeled for your convenience. Follow the directions given you below, make accurate observations and answer questions as indicated.
Record all observations and answers on the answer sheet provided.

1. Observe tube X and record your observations. Compared to a fresh broth solution describe any differences.
   (a) What evidence is there for the presence of living organisms.

2. Now observe tubes Y and Z. These were both boiled in a water bath for 15 minutes. One was sealed before removal from the water bath. The other was left open. Compare these with 2 others that are similar but fresh cultures. Record any changes. Now compare tubes Y and Z relative to the appearance of the materials in both tubes.
   (a) How can you explain the changes in the open tube?
   (b) Does this support abiogenesis or biogenesis? (c) Why?

3. Next observe the tubes marked #1, #2, #3, and #4. They have all been boiled in a water bath for 15 minutes. Tube #1 was left open. Tube #2 was plugged with a 1 hole stopper while #3 received a solid stopper. In tube #4 an S-shaped tube was placed in the 1 hole stopper. Compare this set of 4 tubes with a similar set of freshly prepared broth. Record the differences that you note.
   (a) How do the differences support the theory of biogenesis?

4. Inspect the following data table concerning the population numbers of a microorganism in an open test tube of broth that had been boiled for 15 minutes.

Time in Hours	Average number of microorganisms/field
0	0
12	236
24	478
36	1013
48	1287
60	842
72	365

Draw a graph for this table of data on your answer sheet.

(a) Why were there no organisms at 0 hours?

(b) Describe your graph line.

(c) If there was no life at 0 hours how do you account for the presence of microorganisms at 12 hours.

(d) Does this graph support abiogenesis or biogenesis.

(e) Why do you think the population "crashed" after 48 hours?

(f) What do you think will happen to this culture at 84 hours?

(g) If the original culture were poured into a fresh culture of the same volume at 48 hours then what would you expect to happen?

(h) Why?