SECTION IX

LABORATORY INFORMATION

1. Use of Microscopes
2. Statement about Dissection
3. Sample Lab Reports
4. Model for Conducting a Science Fair

"The one who searches always finds."
Luke 11: 5

MICROSCOPY

The microscope is an integral tool for studying the life sciences. With the aid of the microscope, scientists have learned detailed concepts of microorganisms, cell structure and function and the compounds of living organisms. The concept and use of the microscope should be introduced in the early grades and continue throughout high school. Below is a suggested timetable of when concepts and topics about microscopy should be introduced and mastered.

K – 2	Magnification, using hand lenses
3 – 5	Proper use of types of microscopes (compound, dissection) Use and care of microscopes Observing small objects (dissecting) Observing preserved slides
6 – 8	History of microscopy Parts of the microscope Determining low and high power magnification
9 – 12	Expand knowledge and skills in use of microscope (compound) Preparing wet mounts and use of stains Observing and identifying microorganisms in pond water Electron microscopy

PROPER USE OF A MICROSCOPE

CARRYING OF A MICROSCOPE

1. Hold the microscope with one hand on the arm and the other hand under the base.
2. Keep the microscope straight up when carrying so the eyepiece does not fall out.

USING THE MICROSCOPE TO VIEW A SPECIMEN

1. Make sure the microscope has the lowest power objective in place and this objective is as close to the specimen as possible.
2. Adjust the light source (mirror or light).
3. Use only lens paper to clean the objective and eyepiece.
4. Place the slide on the stage. Place the stage clips, if present, onto the slide to hold it in place.
5. As you look through the eyepiece, slowly raise the lowest power objective using the coarse adjustment knob until the specimen gets into focus.
6. Use the fine adjustment knob to complete the focusing of the specimen.
7. Most microscopes are par focal, which means when a specimen is in focus under one objective, it is in focus in all other objectives. To increase magnification, carefully switch the objective lens to the next higher power. You should only use the fine adjustment knob to make the image clearer. **NEVER USE THE COARSE ADJUSTMENT KNOB WHEN USING THE HIGH POWER OBJECTIVE!**
8. Repeat the same procedure for each slide you examine.
9. When finished using the microscope, remove the slide. Then make sure the lowest objective is in the viewing position and that it is as close to the stage as possible. Unplug the electrical cord, if present, and wrap it around the base. Clean the lenses.
10. Return the microscope to its proper storage location.

TYPES OF MICROSCOPES

STEREOMICROSCOPE

Relatively low magnification
Usually 4x to 30x
Used for viewing
Manipulating larger objects

COMPOUND

Contains more than one lens
Magnifies image up to 1000 times
Useful in studying many kinds of cells and small organisms
Can be used to study live specimens

ELECTRON

Uses a beam of electrons instead of light to examine a sample
Magnified images as much as 1000 times
Larger than a light microscope

TYPES

Transmission Electron Microscope (TEM)

- shines beam of electrons on sample
- magnifies image on fluorescent screen
- specimens must be cut into very thin slices

Scanning Electron Microscope (SEM)

- uses beam of electrons to scan surface of the sample
- collects electrons that bounces off sample and forms image on television screen

Scanning Probe Microscope

- does not use lenses
- traces surface with a tiny tip as a probe
- have produced pictures of individual atoms

COMPOUND MICROSCOPES
PARTS AND FUNCTIONS

EYEPIECE	Contains a magnifying lens
ARM	Supports the body tube
STAGE	Supports the slide being observed
OPENING OF STAGE	Permits light to travel up to the eyepiece
FINE ADJUSTMENT	Moves the body tube slightly to sharpen the focus
COARSE ADJUSTMENT	Moves the body tube up and down for focusing
BASE	Supports the microscope
ILLUMINATOR	Produces light or reflects light up through body tube
DIAPHRAGM	Regulates the amount of light entering the body tube
DIAPHRAGM LEVER	Open and closes the diaphragm
STAGE CLIPS	Holds the slide in position
LOW-POWER OBJECTIVE	Provides a magnification of 10X and is the shorter of the objectives

COMPOUND MICROSCOPES (cont'd)

HIGH-POWER OBJECTIVE	Provides a magnification of 43X and is the longer of the objectives
REVOLVING NOSEPIECE	Contains the low and high power objectives and can be rotated to change magnification
BODY TUBE	Maintains a proper distance between eyepiece and the objective lenses

Teacher Comments:

ANTON VAN LEEUWENHOEK'S SIMPLE MICROSCOPE

Microscopy began with Anton van Leeuwenhoek (1632 – 1723), a Dutch businessman-amateur scientist who ground lenses to use in simple microscopes. He made over 400 such instruments and used them to make the first important observations in cell biology. It was Leeuwenhoek's work that pointed to the existence of a whole new category of living organisms invisible to the naked eye and totally unknown to science.

LEEUWENHOEK'S MICROSCOPES

Principle

A simple microscope uses a double-convex lens with two outwardly curving sides to produce an enlarged virtual image of an object.

How it worked

This example consisted of a small, flat, metal plate into which a double-convex lens was fixed, specimens were placed on a pin that could be adjusted by turning screw to focus.

LEEUWENHOEK'S OBSERVATIONS

In 1672, Leeuwenhoek sent sketches and descriptions of his observations to the Royal Society in London, the foremost scientific organization of the time. This excited much interest and was the start of a long correspondence with the Royal Society. He wrote 165 letters to the society before his death in 1723. Many of these letters were published in the society's journal, *Transactions of the Royal Society*.

Leeuwenhoek was the first to observe unicellular organisms (protists) and, in 1679, human sperm cells.

COMPOUND MICROSCOPES: IMAGE FORMATION

Dutch spectacle maker Zacharias Janssen (1580 – 1609) and physicist Cornelius Drebbel (1572 – 1634) had made compound microscopes some years prior to Anton van Leeuwenhoek's work with simple microscopes. However, these early compound microscopes had poor quality lenses and could not match the resolving power of Leeuwenhoek's instruments. With improvements in lens making technology, however, the superiority of the compound design became apparent and it was adopted as the standard for biological research.

PRINCIPLE

Compound microscopes use a secondary lens to magnify the image produced by a primary lens.

HOW THE IMAGE IS FORMED

1. Light is reflected off a mirror through a condenser lens onto the specimen.
2. The objective lens – a double-convex lens with two outwardly curving sides – forms and enlarged real image of the specimen.
3. This real image is viewed through an ocular, or eyepiece, lens – also a double-convex lens. This produces the enlarged virtual image that is seen by the eye.

MAGNIFICATION

A factor equal to the magnifying power of the objective enlarges the final image and the ocular lens multiplied together. For example, the image from a 40 objective lens viewed through a 10 ocular lens will be magnified by a factor of 400 times ($40 \times 10 = 400$).

LIMITATIONS

An optical, or light, microscope cannot resolve images of objects that are smaller than the wavelength of visible light, giving a maximum magnification of about 2,000 times.

ADVANCED COMPOUND MICROSCOPES

Oil Immersion microscopes

Very powerful objective lenses that can magnify an object up to 100 times are used with oil that fills the space between the lens and the specimen. The optical qualities of the oil allow clearer pictures than if the space is filled with air.

Binocular and stereoscopic microscopes

Some instruments have binocular eyepieces that provide an eyepiece lens for each eye. Stereoscopic instruments have a set of objective and eyepiece lenses for each eye, providing a three-dimensional image of the specimen.

Teacher Comments:

SUGGESTED GUIDELINES
REGARDING THE DISSECTION STUDY AND USE OF ANIMALS IN K – 12 CLASSROOMS

The Diocese of Trenton is dedicated to teaching and developing responsible attitudes and a general respect and reverence for all living organisms. We also recognize the historical and current importance of animals in the field of science, especially in the area of research. After careful consideration of various current views, the curriculum committee highly encourages the following guidelines be adapted in all Diocesan science classes. Alternative ideas are attached.

- Based on our philosophy, we highly recommend that **vertebrate** dissections be discontinued with the exception of Advanced Biology classes.
- **Invertebrate** dissections may be undertaken for scientific purposes. When possible, purchase specimens from grocery stores. All dissections selected should be part of the curriculum and the seriousness of the activity should be stressed to the students. **Always stress safety** and teach the proper use of dissection tools.
- No student should be forced to participate in any dissection. Alternative methods should be made available, e.g., *computer software, videos, Internet activities,* for students to study the anatomy of both vertebrate and invertebrate species. **All students**, whether or not they participate in a class lab, should be held responsible for the academic material.
- When conditions permit, living organisms, both plant and animal should be kept in the classroom where students can experience and learn to appreciate various species, as well as, care for them and study their behavior. State and local regulations for the care of these animals should be enforced at all times. Studies should also occur in natural habitats when possible.
- The curriculum committee believes that student research techniques are not properly developed at the pre-college level to permit the use of **vertebrate** animals in class or school science fair projects. All such research should be prohibited. This guideline agrees with **ISF rules and regulations**.

ALTERNATIVES TO DISSECTION
RESOURCES FOR EDUCATORS

For more information about alternatives to classroom dissection, including software and model loan programs, please contact the following organizations:

Alternative loans are available from:
Humane Society of the United States
2100 L Street, NW
Washington, DC 20037
301-258-3042 www.hsus.org

A catalog of alternatives, Beyond Dissection, is available:
Ethical Science Education Coalition
333 Washington Street, Suite 850
Boston, MA 02108
617-367-9143

For information on specific alternative projects contact:
National Association for Humane and
Environmental Education
67 Norwich Essex Turnpike
E. Haddam, CT 06423
860-434-8666 www.nahee.org

A program to teach students about environmental and animal issues
CD-ROM and model loans are available as well from:
Animal Learn
801 Old York Road, #204
Jenkintown, PA 19046
800-729-2287

SAMPLE OF RUBRIC
MC CORRISTIN CATHOLIC HIGH SCHOOL
SCIENCE DEPARTMENT
FORMAL LAB REPORTS – GRADING CRITERIA

Note: All labs will not contain **all** of the following sections.

Safety Procedures

- all safety procedures were followed = 2
- had to be reminded of some procedures (goggles, etc.) = 0
- major safety procedures were not followed = 0 for the whole lab

Title

- title present = 1
- title absent = 0

Purpose

- states clear, accurate purpose = 3
- purpose present, wording may not be clear, spelling and grammar mistakes = 2
- purpose stated is not relevant to the lab = 1
- fails to present any purpose = 0

Materials

- all materials accurately listed = 2
- most materials listed, some not listed = 1
- material section not present = 0

RUBRIC (cont'd)

Hypothesis

- states clear, concise, appropriate hypothesis = 3
- hypothesis appropriate, but not worded clearly; may contain spelling or grammar mistakes or is incomplete = 2
- hypothesis not relevant for the topic of the lab = 1
- hypothesis not present = 0

Procedure

- steps listed clearly, accurately and in proper sequence = 3
- one or two steps are not precise, in proper sequence or missing = 2
- most of the procedure is confusing, not non-sequential or missing = 1
- procedure not present = 0

Descriptive Observations

- statements are clear, concise, accurate and in full sentence format = 6
- observations are generally clear, one or two statements may lack detailed descriptions or contain incomplete sentences = 4
- observations are sentence fragments and/or contain vague or incomplete information = 2
- no observations are noted = 0

Data (Measurements)

- data collected is accurate, uses proper units and presented in proper format (tables, charts, etc.) = 8
- date is generally correct but not organized in proper tables, chart or listing = 4
- no data is present = 0

Calculations

- accurate formula stated, data with units used correctly, calculations are accurate and all work is shown = 8
- formula information incomplete or contains some calculation mistakes = 4
- formula not stated or calculations missing or incorrect = 0

RUBRIC (cont'd)

Graphs

- graphs are accurate, neat with proper labeling = 8
- graphs are generally accurate, label missing, careless formatting = 6
- some data plotted inaccurately, labels missing, careless formatting = 4
- graphs are inaccurate (x and y axis) or not spaced properly = 2
- graphs are missing = 0

Analysis

- produces an analysis consistent with the data collected. all questions are answered correctly in complete sentences and in third person = 4
- student analysis is basically sound, questions generally are answered correctly in complete sentences = 3
- student analysis is absent, questions are answered in sentence fragments or are incomplete = 2
- student analysis is absent, some questions are missing = 1
- analysis is absent = 0

Conclusion

- draws a conclusion that is supported by the data and gives supporting evidence for the conclusion = 3
- draws a conclusion that is supported by data, but fails to show any evidence for the conclusion = 2
- draws a conclusion that is not supported by data = 1
- fails to reach a conclusion = 0

Formatting of Lab

- headings are underlined, lines skipped between major sections = 2
- headings are present, but underlining or skipped lines are missing and/or sections are out of order = 1
- headings not present = 0

Mc CORRISTIN CATHOLIC HIGH SCHOOL
HAMILTON TOWNSHIP, NEW JERSEY
FORMAL LAB REPORT
STUDENT SCORING FORM

Section	Grade
Safety Procedures	
Title	
Purpose	
Materials	
Hypothesis	
Procedure	
Descriptive Observations	
Date (Measurements)	
Calculations	
Graphs	
Analysis	
Conclusion	
Formatting of Lab	

SETTING UP A SCIENCE FAIR
TOPICS FOR THE COORDINATOR TO CONSIDER

WHY A SCIENCE FAIR?

A science fair provides a unique opportunity for students to engage in a long-term research project and investigation. It will require the use of the scientific method as well as research and library skills. In addition, it gives students a chance to develop their communication skills as they prepare a written report and oral presentation.

KINDS OF PROJECTS

There are four categories of science projects: models, demonstrations, collections and experiments. Each of these has value; but, only the last category, experiments, really tests a student's ability to emulate a research scientist. The other kinds of projects ready do nothing to promote the use of the scientific method. You may choose to allow students to develop models, demonstrations or collections for a science fair; however, we suggest you consider only allowing experimental projects. The other types are often nothing more than a sharing of established principles and laws. The experimental project requires students to use methods of research and inquiry similar to those used in the scientific community. In addition, the student is challenged to establish a hypothesis, design an experiment, collect data, interpret the data and draw conclusions based on that data. An experimental project will promote research and study skills, creativity and give a student first hand experience using the experimental process.

THE SCIENTIFIC METHOD

This is an organized way of thinking about problems. It has evolved over hundreds of years as people have attempted to develop a systemic approach to problem solving. There are five parts to this method:

1. STATING THE PROBLEM – A question comes to mind. It is often established from the observation of nature. Why does something appear to happen as it does, or what if this were different?

2. HYPOTHESIS - This is an explanation for the established problem. A student establishes an explanation to be tested.

3. OBSERVATION AND EXPERIMENTATION – Observation has led to the original problem and the student's hypothesis or explanation for it. Now an experiment must be designed to test the validity of the hypothesis.

4. INTERPRETATION OF DATA – During the experiment, measurements and data are collected. The student must evaluate and interpret these results.

5. CONCLUSIONS – Finally the interpretation of results compared to the original problem and hypothesis will lead to the establishment of conclusions. The hypothesis is either supported or disproved and conclusions can be drawn.

SAFETY CODES AND ANIMAL ENDORSEMENTS

It is very important for you to check with the state about safety codes and endorsements related to the handling of animals and bacteria. Write to the Department of Education in your state to request information. Laws have been established to insure the safety to science fair participants and the animals they may be studying.

SCHEDULING

A science fair project is a long-term project requiring between three and four months of preparation. Consider introducing the fair in October or November and having the actual fair and judging in January or February. Dates will depend on many factors such as:

- availability of school facilities
- best time for teachers, parents and students
- date of regional and state competitions

Develop a method for having participants share their progress with you. Because this is the first time many students will have worked on such a long-range project, you should monitor their progress regularly. Consider using forms such as the ones found on the duplicating master called "Monitoring Forms."

JUDGES

You might be required to recruit judges for the fair. A team of at least 2 judges should evaluate each project. Each team of judges should be responsible for around 7 to 10 projects on the day of the fair.

You'll want judges who have had experience working with young people. The fair should be a positive experience for everyone. Judges must know how to interact with students and reinforce the good as well as point out areas for improvement. The judges should be knowledgeable in the sciences and experimentation. Seek out teachers, administrators, senior citizens or college students. Many times parents who work in scientific professions make the best judges.

SCIENCE FAIR (cont'd)

JUDGING

The judges should use some kind of evaluation form such as the one supplied in this package. Encourage the judges to include comments on the evaluation forms. Judges should look for the following:

- knowledge of project and topic
- demonstration and use of scientific process
- knowledge of scientific principles
- neat and well organized exhibit
- creative approach to research and exhibit
- complete abstract and research paper
- a degree of individual commitment and work.
- judges should be realistic and realize that kids developed these projects.

AWARDS

Awards such as ribbons or certificates can be a good motivation to students and help to recognize their accomplishments and efforts. The awards should not be the sole reason a student participates. Participation in a science fair should be based on an interest to learn more about a particular topic and a desire to conduct an experiment using the scientific method.

Consider handing out awards during an evening assembly so that parents and relatives can attend. The actual judging of the exhibits could take place during the day and then a special assembly could be set up so that visitors can view all the exhibits in the evening. Presentations can be made and then exhibits could be dismantled and taken home so that the school facility isn't over-run with projects for two weeks. The main purpose here is to showcase the fair for family and friends and to provide participants with the recognition they deserve.

CATEGORIES

Science fair projects are usually grouped into categories related to the field of science they cover. Here is a suggested list of categories:

AEROSPACE – The study of the atmosphere and outer space; also the design of aircraft and the study of airflow
BEHAVIORAL SCIENCE – The study of animal behavior, learning, perception and motivation
BIOCHEMISTRY – Chemical processes such as digestion, respiration and photosynthesis
BOTANY – The study of plants

SCIENCE FAIR (cont'd)

CHEMISTRY – the study of matter, including the study of compounds, gases, analysis of products and atomic theory
COMPUTER PROGRAMMING – writing computer programs to carry out a particular task
CONSERVATION – study and protection of natural resources
EARTH SCIENCE – study of the earth: geology, geography, oceanography and seismology
ELECTRONICS – design of devices that use electrical circuits
ENGINEERING – design, construction and operation of buildings and machinery
HEALTH SCIENCES – physical and mental health of people
MICROBIOLOGY – study of microorganisms
PHYSICS – study of motion and energy including sound, heat and light
ZOOLOGY – study of animals

REMINDER
Check with your state about safety codes and regulations regarding the handling of animals and bacteria. Be sure to emphasize proper care when working with chemicals, electricity and anything else that has the potential of causing injury or harm.

Criteria should include connection to other disciplines such as, Language Arts, and Mathematics. Students should be able to integrate the skills and concepts of correct Language Arts usage, vocabulary and correct spelling into science fair reports. This connection should be considered in the judging process.

SAMPLE
SCIENCE FAIR
JUDGES' SCORE SHEET

Student's Name ______________________________

Grade ____________ School ______________________________

Category ______________________________

Title of Project ______________________________

(Circle score next to each category – 10 is highest)

Knowledge Gained (Has student acquired knowledge by doing this project?)	1	2	3	4	5	6	7	8	9	10
Information (Information collected through research valid and appropriate to the grade level?)	1	2	3	4	5	6	7	8	9	10
Scientific Approach (Was a scientific approach and controlled variable used in conducting the experiment?)	1	2	3	4	5	6	7	8	9	10
Collection of Data (Were measurements accurately taken and give in metric units?)	1	2	3	4	5	6	7	8	9	10
Conclusions (Were stated conclusions logical and valid?)	1	2	3	4	5	6	7	8	9	10
Written Work (Abstract present and research paper organized and complete?)	1	2	3	4	5	6	7	8	9	10

SCIENCE FAIR (cont'd)

Oral Presentation (Was it well planned and interesting?)	1	2	3	4	5	6	7	8	9	10
Exhibit (Visually appealing, neat and attractive?)	1	2	3	4	5	6	7	8	9	10
Effort (Degree of individual effort demonstrated)	1	2	3	4	5	6	7	8	9	10
Creativity and Originality (Does project show creative approach or thought in design or presentation?)	1	2	3	4	5	6	7	8	9	10

Comments:

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Outstanding	95 – 100
First	90 - 94
Second	80 - 89
Third	70 – 79
Honorable Mention	1 – 69

Total Score ____________ Place ____________

____________ Judge's Signature

____________ Judge's Signature