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Rotational Learning in the Middle School
Life Science Classroom

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James Lee Merrifield

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ROTATIONAL LEARNING IN THE MIDDLE SCHOOL LIFE SCIENCE CLASSROOM

By

James Lee Merrifield

A THESIS

Submitted to

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in partial fulfillment of the requirements

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ABSTRACT

ROTATIONAL LEARNING IN THE MIDDLE SCHOOL LIFE SCIENCE CLASSROOM

By

James Lee Merrifield

The Rotational Learning model was designed to address a number of problems faced in the middle school science classroom. Middle school students possess many inherent characteristics challenging to any teacher. These characteristics include developmental changes and individual learning styles.

Rotational Learning utilizes cooperative learning groups working through unit objectives. Throughout the unit the students work through three basic rotations. These include note taking, laboratory activities, and library research. The intent is to meet all students' interests and learning styles through hands on activities, traditional teaching methods, and opportunities to explore areas of interest.

Rotational Learning provides an effective instructional technique. It involves all students in hands on/ minds on science. The data from pretest, mid test, and post test scores provide evidence of the effectiveness of the model. The supporting literature indicates the model also meets many of the needs of the early adolescent, in terms of developmental, emotional, and social issues.

ACKNOWLEDGEMENTS

This project and the completion of my degree would not have been possible without the patience and encouragement by my wife, Cathy. Her kind words and efforts were priceless in this endeavor, as there were times when I felt like quitting and calling it a "good attempt." It was her, who prompted me to complete the requirements of the program. To her I owe great thanks.

I would also like to thank Dr. Merle Heidemann for her time and effort during the completion of the Thesis. Her efforts and patience with my many rewrites made the project more enjoyable and possible.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The Rotational Learning Model was developed to address a number of problems in the middle school science classroom. Teachers at the middle school level are well aware of the "excess baggage" middle school aged students bring to class every day. Many middle school teachers, have in jest, referred to middle school students as "Walking Hormones." The Rotational Learning Model was designed to address the inherent characteristics of the middle school student and to improve test and total unit scores. The model would also increase the number of hands on/ minds on activities, and allow the teacher freedom to address individual and small group concerns.

The Rotational Learning Model incorporates a variety of existing methodologies and was so named based on two sets of rotations used in the model. Rotational Learning utilizes traditional teaching techniques, cooperative learning groups, and learning stations to help students develop an improved understanding of the unit objectives. The model utilizes two separate rotations. In the first, student learning groups move through a series of rotations that include note taking, library research, and laboratory activities. In all three endeavors the students have basic guidelines to follow, using a combination of traditional teaching methods, alternative methods of evaluation and student opportunities to explore areas of interest in more detail. The second rotation involves the evaluation processes and includes an exit interview and a group generated video presentation.

For the purpose of this study the model was used with a middle school eighth grade science class. The unit of study was Life Processes, including photosynthesis, respiration, and fermentation. The Life Processes unit was selected because it has been difficult for students in the past, had relatively few hands on activities and is the basis of all future life science studies. It should be noted that Rotational Learning is well suited for other science units, and with other subject areas.

The research was conducted over four years. The project sought to compare the old traditional teaching style of the instructor with the new methods of Rotational Learning. The traditional style included lecture, reading assignments, filmstrips and demonstrations. Students worked alone, in step with their peers. Rotational Learning utilizes cooperative learning groups, which work on various hands on/ minds on activities. Ideally, through social interaction, peer tutoring, and self/ group decision making, unit and test scores should improve.

Individual learning styles were a consideration in the research. The differences in student abilities and interests make the traditional methods of teaching more difficult. With Rotational Learning the students have a more equal opportunity to meet the objectives, despite their interest areas, abilities and style of learning. The intent was to increase the students level of understanding of the unit objectives (see Appendix B).

During the past eight to ten years I have been experimenting with different teaching styles. Through this experimentation and the time I have spent with middle school students, I have found that certain students do better with particular teaching styles. The challenge to develop a new unit for this project centered around three discoveries I made over these years. One, there are distinct developmental stages and accompanying problems which early adolescents face at this time of their lives; two, middle school reform is taking place in many districts; and third, there are many different learning styles in a heterogeneous group of learners.

The developmental stages of the early adolescent are challenging for the student and the instructor alike. Young adolescents are often viewed in one of two ways: As individuals with characteristics determined by their particular stage of development, or as individuals in that stage of development in search of expectations and meaning in the world at large. Early adolescents are young people, still very much in the process of forming a sense of self and social meaning (George [et al.], 1992).

The developmental framework of the early adolescent brings many factors to their education. According to Charles (1980), differences in physical development among this group of students bring two phenomena into play. The first is the onset of puberty, which brings with it bodily changes accompanied by emotional effects that influence learning and in school behavior. The second phenomena concerns the sudden onset of physical growth. At this time, growth spurts often result in tremendous physical variations among classmates. Differences among students result in peer comparisons and the sudden awareness of self. Bodily changes and awkwardness add to this self awareness and often distract the young adolescent from classroom learning. This second phenomena is often associated with athletic skills. A few individuals will excel in athletics while others struggle. The results often lead to the athlete having little motivation to to do well in the classroom (Charles, 1980). At the same time less athletic individuals may become more self conscious about their physical differences.

Young adolescents are beginning to think for themselves, moving from concrete thinking to abstract thinking. Socially, they are developing new attitudes toward authority and beginning to test the limits imposed on them. Young adolescents begin to examine more carefully the personalities and traits of the grownups they are directly responsible to (George [et al.], 1992). During early adolescence, youngsters tend to be more concerned with teachers' personal attributes than their teaching skills or knowledge of the topic matter.

George [et al.] (1992) summarized a 1961 report that identified the best contemporary junior high schools. These were characterized by moderate size, block of time instruction, flexible instruction, teachers trained and devoted to the teaching of young adolescents and modernistic instructional techniques. In terms of the middle school reform movement we are beginning to see a push for these same characteristics again. The movement is towards a curriculum design that will respond to the characteristics and needs of young adolescents. It has been my experience with middle school level education that the major push in school improvement is based on the premise that all students can succeed. Since 1986, when I began teaching, I have witnessed and been part of changes in core curriculum development, a grade six through eight alignment of the middle school, and changes in middle school philosophies concerning extra curricular activities and athletics (for example; no cut policies).

Several times over the past few years, I have heard about differences in learning styles among individuals. As individuals we all exhibit our own general approach to learning and organizing information (Jones, 1990). Learning style inventories can provide teachers and learners with information about student learning style preferences. An assessment of learning styles can encourage teachers to increase the number of instructional activities that will help bring meaning to the student (Jones, 1990). Based on this premise the Rotational Learning model was designed to provide a wide variety of instructional activities. The intent was to provide equal opportunity for all students to master the unit objectives, using their own learning styles.

Learning how to recognize and appreciate differences in learning styles can help teachers to identify the natural strengths and tendencies of individual learners (Tobias, 1994). To learn more about learning style preferences, I conducted an assessment of my students during the 1995 - 1996 school year. The assessment tool used was the "Dominant Learning Style Characteristics" assessment , outlined in The Way They Learn, (Tobias, 1994). This particular assessment breaks the learning styles down into four combinations based on perception and ordering skills.

The way in which a learner takes in information is called perception. There are two basic ways information is perceived: **concrete perception** allows information to be taken in directly using any or all of the five senses. **Abstract perception** allows us to visualize and understand qualities of information that are not directly observable. The way in which the learner organizes and uses information is called Ordering. There are two basic ways information is ordered: **sequential ordering** is the organization of information into a step by step system, **random ordering** utilizes a clumping fashion that is in no particular sequence.

Using the perception and ordering parameters in combination, four distinct learning styles emerge. Each person has a dominant learning style they prefer but, they use all four. The four basic learning styles identified were; Concrete-Sequential, Abstract-Sequential, Abstract-Random, and Concrete-Random.

The **Concrete-Sequential** learner is typically well organized, specific, and conscientious. They are most comfortable if there is a pattern or specific routine to follow. The **Abstract-Sequential** learner is usually systematic and precise with readily available knowledge. They often analyze every detail before making a decision. The **Abstract-Random** learner is spontaneous and generally concerned about the others involved in the process. They often appear unable to take a hard stand for any issue, because they will try to satisfy the needs of the others involved. The **Concrete-Random** learner will thrive on independence and are often creative individuals. They work better with guidelines not rules and are often viewed as not being team players.

Based on the results of my classroom assessments for learning styles, all four styles were exhibited among students in each class period. The Concrete-Sequential, Abstract-Sequential, and Abstract-Random learning styles were equally represented in all class periods. The style least often observed was the Concrete-Sequential style. Not enough data was collected at this time to compare learning styles with success in meeting the unit objectives. However this may be an interesting recommendation for further studies. Based on general observations it is my opinion that the presence of varied learning styles among students supports the use of the Rotational Learning model in the classroom.

The test school for which the Rotational Learning model was studied was a middle school, the only one in the district with grades six, seven, and eight. The eighth grade population averages 250 students, of which the majority are Caucasian. The school district is the largest in the county, is made up of a fairly large geographical area and is primarily rural. The county is ranked 30th in the state based on population density. The test school is located in the largest of four towns and villages within the school district, having a population slightly over 6000 people.

Slightly less than 50% of the middle school students live with both parents, and nearly 100% of the single parent households consisted of moms. Almost 80% of the children had mothers in the work force. Without statistical data to support my observations, it appears that a large number of students have little or no parental supervision from the time they leave school until their parent(s) arrive home from work. One out of seven middle school students live in poverty. The community as a whole has 30% of the population making less than $15,000 annually and 50% make less than $25,000 each year. The breakdown of the population by race includes 93% White, 5% Black, and 2% Hispanic.

The school system developed a K - 12 Science Curriculum, with units and objectives based on the Michigan Essential Goals and Objectives for Science Education. By the beginning of the 1991-92 school year the K - 12 Science Curriculum Committee established a set of science objectives for each grade level. The objectives were arranged into units and distributed to every elementary and secondary science teacher in the system. At the eighth grade level, the objectives are divided among eight units which works out to two units each quarter.

One unit that proved particularly troublesome to the eighth grade students was the Life Processes unit. The old approach used many traditional methodologies including, lecture, reading assignments, films, and demonstrations, with few hands on/ minds on activities. This was a growing concern as the development of new middle school philosophies emerged in the district. It was obvious that methods needed to change in order to improve the success rate of the middle school students. The unit activities and post test were based on the unit objectives which in turn were based on the Michigan Essential Goals and Objectives for Science Education (see Appendix C). The major themes of the unit were centered around the biological processes of photosynthesis, respiration, fermentation, and biosynthesis. These concepts were then applied to biotechnology. The unit assumes the students have a basic understanding of chemical formulae and balancing equations. This is a reasonable assumption since these objectives are taught in the seventh grade.

Photosynthesis is essential for life: if this process did not take place the carbon dioxide- oxygen cycle would not exist. In a study done by Eisen and

Stavy (1988), an attempt was made to find out how well students understand the role of photosynthesis in the biological world. The results of the study indicated that most adults understand the carbon dioxide/ oxygen cycle, but were only able to perceive photosynthesis and respiration as a simple gas exchange (Eisen and Stavy, 1988). Many adults do not understand how plants use carbon dioxide and water to produce the organic compounds used in the process of respiration. In response to the study, the M.E.G.O.S.E. objectives, and Benchmarks established by the American Association for the Advancement of Science; photosynthesis and related concepts are taught at the middle school level. Many students do not take advanced biology courses at the high school level. Therefore at the middle school level a general understanding of the concepts can allow the students to apply this knowledge to everyday situations throughout their lives. The intent of the Rotational Learning model was to teach the concepts so students could develop their own personal understanding of the objectives.

This study encompassed four years in an attempt to measure the effectiveness of presenting the eighth grade science, Life Processes unit using the Rotational Learning model. During the 1992-93 school year the unit was taught using only the instructor's traditional methods of teaching. This data was collected to compare my previous style of teaching used before the 93-94 school year with Rotational Learning. During the 1993-94 school year, only part of the Rotational Learning model was in place. The transitional year did not provide complete data. However, it was included for comparison purposes. Most of the data used to determine the effectiveness of the learning model came from the 1994-95 and 1995-96 school years.

IMPLEMENTATION OF UNIT

The following is a basic outline of the Life Processes unit. Twenty one days are required to complete the unit as it was designed for the thesis study. Lesson plans for teaching the Life Processes unit have been included for reference (see Appendix A). The Life Processes unit began with a pretest, which was written based on unit objectives (see Appendices B and C). The pretest was designed to demonstrate the learners' prior knowledge of the objectives. The pretest scores were used as a base line for evaluating the Rotational Learning style compared with the instructor's traditional style .

The Rotational Learning model uses traditional and new methodologies to teach and reinforce the objectives. The Life Processes unit objectives were presented formally, twice during the unit. The first time was in a more traditional fashion. Lectures, reading assignments, filmstrips, worksheets and demonstrations were used, but very few hands on/ minds on activities were used. The second time through the objectives the students were placed in cooperative learning groups. The objectives were taught using the Rotational Learning model. Hands on/ minds on activities are the primary focus of the Rotational Learning. This model utilizes three basic learning stations which students cycle through: note taking, laboratory activities, and library research.

Rotational Learning allows the students to interact with one another in making decisions about how they would meet the objectives. The styles of instruction are varied to help accommodate the various learning styles of middle school students. The traditional style of instruction served as an introduction to the objectives and to some degree simulated the old methods of teaching the unit. This allowed for a "rough" comparison of the traditional style of teaching and the Rotational Learning model. For comparison purposes the traditional method of instruction was followed by a mid unit test (see Appendix I). The intent was to show improvement in students understanding of the unit objectives. The mid unit test scores were compared with the pretest scores and later to the post test scores.

The Life Processes unit objectives were first presented to the students using my traditional style of instruction. This portion of the unit required six days to complete. On the first day students developed a vocabulary list from the unit objectives (see Appendix C). This vocabulary list was completed by each student to develop an understanding of the basic terminology. For the next five days the unit objectives were covered through a series of worksheets and a filmstrip titled Photosynthesis and Respiration.

The first worksheet was used to review chemical equations, atoms, and molecules (see Appendix D). The equations for photosynthesis and respiration were introduced and the students were exposed to the idea that the two equations are reciprocal. The next worksheet reinforced the students understanding of the two equations (see Appendix E). Once the students had a basic understanding of the two equations they were shown a filmstrip with an accompanying worksheet (see Appendix F).

Throughout the traditional method's portion of the unit, students worked independently with little interaction with their classmates. The final activity before the unit mid test involved concept mapping (see Appendix H). The students were instructed to develop a concept map using the key terms from the unit objectives. The concept maps were prepared by each student, and finally shared in cooperative learning groups the day before the mid test.

The original intent of the traditional teaching portion was to provide comparison between my traditional teaching style and the Rotational Learning. It became apparent the students needed an introduction to the Life Processes objectives and the traditional methods portion provided an effective transition into the rotational learning.

The Rotational Learning portion of the unit utilized cooperative learning groups. These groups were established by using the pretest scores. The highest pretest score was paired with the lowest pretest score and the two median scores in the class. The next highest score was then paired with the next lowest score and two remaining scores in the middle. This method continued until all students were placed in a cooperative group of four students. If the class roster was not divisible by four, one or more groups of three were accepted. The intent of this method of grouping was to establish homogeneous groups with approximately the same composite level of prior understanding of the objectives.

The students were placed in cooperative learning groups to encourage socialization, peer tutoring, and to make the students accountable to peers, which allowed for an alternative method of evaluation. The students were introduced to Rotational Learning with a preview of the three basic learning stations: note taking, laboratory research, and library research. At this time the students were instructed on the two components of record keeping for which they would be responsible. These included time sheets, and group/ self evaluation forms (see Appendices R and S).

Each student group discussed and selected one of four topics for an in-depth study; photosynthesis, respiration, fermentation, and biotechnology. Each topic had to be selected by at least one group to ensure the research for each topic was shared with the entire class. After the introduction and topic selection the students were taken to the library for an introduction to the resources. The balance of the period was used to begin searching for topic information and to make practice note and bibliography cards. The librarian reviewed with the students where to find materials, library procedures and expectations. She also graciously agreed to supervise the research groups on their days in the library. This supervision was essential so the teacher could remain in the classroom to facilitate the note taking and laboratory research which were taking place concurrently.

The Rotational Learning portion of the unit consisted of two sets of rotations. The first set was three, two-day rotations and the second having three, one-day rotations. The activities for each set of rotations were designed so any order could be followed through the rotations. This was necessary so all groups could be working at the same time. All class periods were 45 minutes long, allowing limited class time for student groups to complete the assigned tasks. This made it necessary for the students to work outside class. The design of the Rotational Learning model helped the students to be more efficient each day.The groups could begin working each day with little delay.

During the note taking rotation the learning groups used a laser disc player to view a series of movie clips and frames related to the unit objectives. A worksheet (see Appendix O) allowed the learning groups to progress through the note taking process without the direct intervention of the instructor. The students were instructed to read several pages from their textbooks and take notes. The notes were used to complete a textbook based worksheet packet (see Appendix P) and turned in the next day for credit. The student group was given a Group Note Review (see Appendix Q) to be completed cooperatively by the group using their notes and worksheets.

A second (two-day) rotation was spent in the laboratory conducting a lab activity which was specific to the group's chosen topic. Each student group was responsible for learning as much about the topic as possible, and communicate the information to the entire class in a video presentation (see Appendix T).

There were four different laboratories carried out by the groups. These were Biotechnology (yogurt making), Fermentation, Photosynthesis, and Respiration.

The Biotechnology groups made yogurt (see Appendix J). This demonstrated the use of live bacterial cultures in the production of a useful product. The focus of biotechnology is the use of living organisms and their processes to benefit humans. The Fermentation groups conducted a laboratory activity to demonstrate fermentation is a type of respiration which does not use oxygen (see Appendix K). This activity was a link between the biotechnology groups and the respiration groups. The Photosynthesis groups explored the role of photosynthesis in the carbon dioxide/ oxygen cycle (see Appendix L) They were able to demonstrate the evidence of materials being used up in the chemical reaction of photosynthesis. Similarly the Respiration groups explored the role of respiration in the carbon dioxide/ oxygen cycle (see Appendix M) They were able to demonstrate the evidence of materials being given off in the chemical reaction of respiration.

The third rotation consisted of two days of library research. The primary goal for each group was to prepare a short term paper and a summary to be used in the video presentation (see Appendix N). The requirements for the library research were for the groups to complete a one to two page paper that identifies the main ideas of the chosen topic and to explore any area of interest related to the topic. The second portion of the paper was designed to allow the students an opportunity to construct their own understanding of the topic.

A second set of rotations consisted of three, one-day rotations, focusing primarily on evaluation. One day was spent in an exit interview with the teacher (see Appendix U). The students were asked a series of questions to check the group's understanding of the Life Processes objectives. Each student was given an opportunity to express their opinion about the Rotational Learning model and how they felt the group worked as a cooperative learning team. Another day the students presented their research paper and summary of their laboratory procedures and results (see Appendix T). The requirements for the video presentation included a four to five minute time period with all group members having an active role. The presentation was supposed to explain the procedures and results of the laboratory activity and summarize the research paper. On the third day the groups were audience members for presentations.

The students were expected to turn in all records at the conclusion of their video presentation. The cooperative learning groups were divided equally among the stations, with only two or three groups working at any given station each day. The two sets of rotations are outlined in Figure1 and 2.

Figure 1 - Example Schedule Of Two-Day Rotations

ROTATION 1 (2 DAYS EACH)

	FERMENTATION	PHOTOSYNTHESIS AND RESPIRATION	BIOTECHNOLOGY
MONDAY TUESDAY	LIBRARY	LABORATORY	NOTE TAKING
WEDNESDAY THURSDAY	NOTE TAKING	LIBRARY	LABORATORY
FRIDAY MONDAY	LABORATORY	NOTE TAKING	LIBRARY

Figure 2 - Example Schedule Of One-Day Rotations

ROTATION 2 (1 DAY EACH)

	FERMENTATION	PHOTOSYNTHESIS AND RESPIRATION	BIOTECHNOLOGY
TUESDAY	PRESENTATION	AUDIENCE	EXIT INTERVIEW
WEDNESDAY	EXIT INTERVIEW	PRESENTATION	AUDIENCE
THURSDAY	AUDIENCE	EXIT INTERVIEW	PRESENTATION

The video taped presentations were shown to the entire class as a review of the Life Processes unit objectives. This was important as not all student groups conducted the same library or laboratory research. The teacher had to facilitate the showing of the presentations to make sure all objectives were covered and to ensure no misconceptions were passed on to other students. The unit ended with a post test consisting of the 17 questions from the pretest and the 17 questions from the mid test (see Appendix V).

In terms of new teaching techniques, very little if anything could be considered original. Many activities were modified to fit the instructor's personal style, time allotments or the academic ability of typical middle school students. Even the Rotational Learning concept was borrowed from other previously existing models of instruction. The originality lies in the organization of the unit not the delivery methods.

The teaching materials used in the thesis unit evolved over several years of teaching. Many ideas, materials, and methodologies were gleaned from textbooks, lab manuals, and workshops. The Masters program for which this thesis was prepared provided course work which allowed for the development and testing of materials used in the unit. The materials used in the unit were all pre tested by the instructor and found to be grade level and content appropriate.

The idea for the Rotational Learning model was born several years ago when I observed a coworker using learning modules to teach science. She always appeared to be well organized, and the students were actively involved with the learning process. The design of the Rotational Learning unit was based on several other learning models already in existence. These models include; Dimensions of Learning (Marzano, 1992), Modularized instruction (Charles, 1980), and Blueprints for Thinking In The Cooperative Classroom (Bellanca [et al.], 1991). The Rotational Learning design attempted to involve the students in constructing personal meaning which could be used in applying the objectives in a meaningful way. The instructor acts as a facilitator rather than the sole means of delivering instruction. This freedom allows the instructor to assist the students in their quest to understand the unit objectives.

EVALUATION

The tools used to evaluate the unit and the students were closely related, since the effectiveness of the unit depended on the success or improved understanding by the students. There were many types of evaluative tools. These tools included traditional written tests and a variety of nontraditional methods, such as observation, exit interviews and the students' application of the unit objectives.

The written tests used in the Rotational Learning model were a pretest, mid test, and post test. These three tests were based on the unit objectives. The questions were written as lower level questions according to Bloom's taxonomy, and evaluated the students' understanding of the objectives at the factual or conceptual level (Jones, 1990).

The students were given the pretest on the first day of the unit (see Appendix B). The intent of the pretest was threefold. It provided the student and the instructor with an understanding of the learners' previous knowledge of the objectives, acted as an introduction to the main objectives of the unit and provided a baseline from which to chart the progress of the student. The pretest was taken by the students and graded in class by a classmate. This allowed the instructor to address previous misconceptions the students displayed and gave the students better insight into the unit objectives.

The mid test covered the same objectives as the pretest. However, the questions varied slightly in format (see Appendix I). The mid test followed the traditional teaching portion of the unit with the intent of checking for student understanding of the unit objectives. In some ways the mid test simulates the old traditional post test from previous years. Based on data collected during the 1994 - 95 and the 1995 - 96 school years (see Figure 3), the students consistently showed improvements in their ability to meet the objectives. As with the pretest , the mid test provided a baseline for comparing the students' progress. It should be noted at this time, that even though the traditional teaching portion was used for comparison purposes, it was also necessary for the introduction of the objectives. This introduction made the Rotational Learning Model possible by giving students a basic understanding of the unit.

The post test as the name implies was given at the end of the unit (see Appendix V). It consisted of questions from both the pretest and the mid unit test. It was designed to measure improvements in student understanding of the objectives. The data consistently showed an improvement in students' scores (see Figures 3 and 4). This suggests that the Rotational Learning model does improve the students' understanding of the objectives.

Figure 3 - Comparison of Pre-, Mid-, and Post Test Scores (94-95)

1994 -1995	PRETEST	MID TEST	POST TEST
TOTAL	36.5	64.9	83.3
FEMALE	39.6	68	84.7
MALE	32.3	63	82

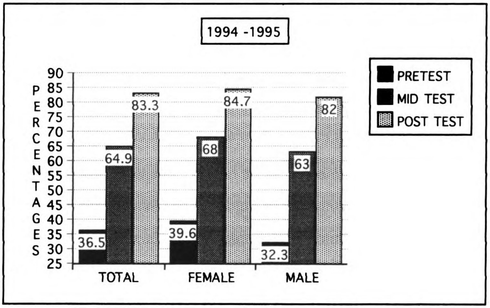
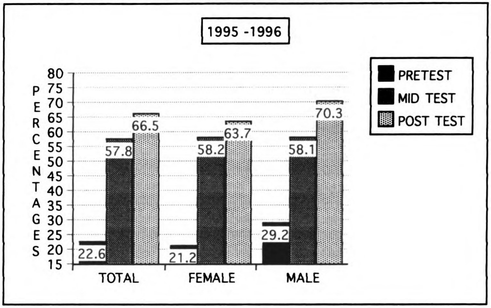


Figure 4 - Comparison of Pre-, Mid-, and Post Test Scores (95-96)

1995 -1996	PRETEST	MID TEST	POST TEST
TOTAL	22.6	57.8	66.5
FEMALE	21.2	58.2	63.7
MALE	29.2	58.1	70.3

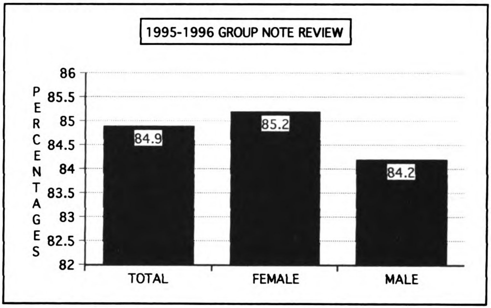


Evaluation was not limited to the three tests. It continued throughout the Rotational phase of the unit, with each rotation containing its own built in evaluation. The note taking rotation utilized notes, worksheets and a group note review. The evaluation for the laboratory rotation was a set of written questions, teacher observations and the group video presentation. The evaluation for the library research consisted of a research paper and the group video presentation.

The note taking rotation focused on all of the objectives and required the students to work both alone and with their cooperative learning groups. The notes were taken from an assigned reading in the student textbook, and from two science based laser disc programs. As homework the students were given a set of textbook worksheets (see Appendix P). The notes and worksheets were turned in and graded based on completeness. This put the responsibility of learning on the students. After all, they should know what they can remember and what they need to write down. This helps students to become responsible, independent learners that have the ability to learn throughout their lifetime (Marzano, 1992). On the second day of the note taking rotation the cooperative groups were given a note review worksheet (see Appendix Q). This review worksheet was to be completed by the cooperative groups using their notes and worksheets. The intent was to initiate discussion and encourage peer tutoring. During the Rotational Learning unit in the 1994 - 95 school year the students checked their own work for accuracy, therefore no data was collected. During 1995-96 the instructor collected the note review sheets. The data indicated the students were able to meet the Life processes unit objectives in cooperative learning groups, using their notes and worksheets (see Figure 5).

Figure 5 - Group Note Review Scores

1995-96	NOTE REVIEW
TOTAL	84.9
FEMALE	85.2
MALE	84.2



The laboratory rotation was unique for each topic selected for study. In general, each laboratory experience was evaluated by a set of written questions that accompanied each laboratory. The students cooperatively completed the lab investigation and answered the questions collaboratively. Percentage scores were used for the four different laboratory activities (see Appendices J, K, L, and M) so equivalent scores could be compared. Due to the nature of the unit, the instructor was able to move freely from group to group and assist the students and monitor student understanding of the objectives. The video presentation, prepared by each cooperative learning group, required a description of the laboratory methods and a summary of the results. The video presentation allowed for an assessment of the students' use of learned knowledge and complex reasoning, rather than a simple recall of lower level information (Marzano, 1992).

Evaluation for the library research rotation was based on the research paper and the summary given during the video presentation. Both evaluation tools had specific criteria outlined in the directions for each (see Appendices N and T). Due to the nature of Rotational Learning, the self/ group evaluations (see Appendix S), were most helpful for the days student groups were in the library doing research. No specific data was compared for the library research rotation, because it was designed to engage students in the construction of personal meaning (Marzano, 1992). To allow students freedom to explore their topic as they chose, only a few guidelines were given for the research paper and video presentations. The guidelines focused more on format, rather than on the content of the paper and presentation. The research papers were evaluated based on completion of the criteria rather than the content of the paper. In other words did they follow directions. Participation was ensured by the expectations of the instructor and the Self/ Group Evaluations. Although this is not in the spirit of the other evaluations, one must realize the importance of the students constructing their own meaning (Marzano, 1992), and the use of all learning styles in the Rotational Learning Model.

Not only was student work from each portion of the Rotational Learning unit evaluated, the unit as a whole was assessed. The unit was designed to be evaluated using the Self/ Group Evaluation, Student Time Sheets, and the Exit Interviews. Only the Self/ Group Evaluations provided significant data.

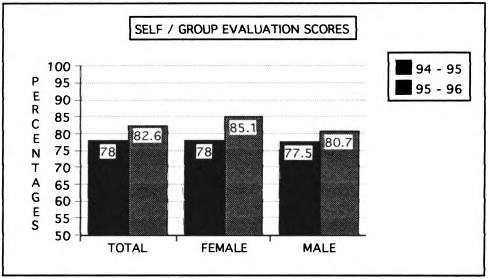
The student time sheets (see Appendix R) were not used for evaluation purposes as too many students did not keep accurate records of the time they spent working on the unit. The use of the sheets, however provided an opportunity for the students to be accountable for their efforts, and to practice a skill they may use someday in the real world. This practice and the self evaluation that takes place by keeping a time sheet, is congruent with the beliefs of George [et al.], (1992), that the middle school should be a place for general education with a curriculum that fully engages the early adolescent in the construction of self knowledge and social meaning. The everyday application of this experience was a first for many of the students.

Due to time constraints, the exit interview (see Appendix U) failed to be a useful evaluation tool. The exit interviews were conducted during the one day rotations at the end of the unit. Some classes required the instructor to conduct three or four interviews during one class period. Many groups were rushed through the interview process or cut short. Even though the quantitative data was not suitable to use here, the responses of the students provided some qualitative input. Another positive aspect of the exit interview was the opportunity for the students to ask specific questions about the objectives before the post test was administered on the last day of the unit.

The students evaluated themselves and their peers within their learning groups based on their daily effort. This was done using the Self/ Group Evaluation form (see Appendix S), which utilized a four point system. A score of four meant the student "pulled their own weight" for the day, and a score of one indicated the rest of the group had to make up for what the student did not do. To compare the students' effort (based on the view of individual students and their peers) with the total unit grades, the scores from the self/ group evaluation forms were totaled for the seven days of the Rotational Learning and converted to percentage scores (see Figure 6). The Self/ Group Evaluations were used during the 1994-95 and 1995-96 school years.

Figure 6 - Self/ Group Evaluation Scores

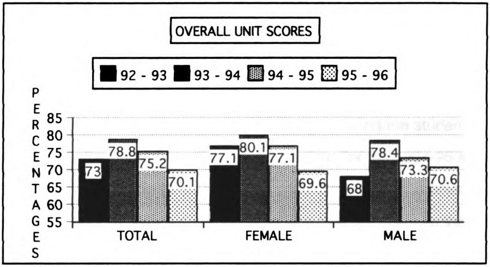
EVALUATIONS	TOTAL	FEMALE	MALE
94 - 95	78	78	77.5
95 - 96	82.6	85.1	80.7



The data shows the students' evaluation of themselves and their fellow group members were slightly higher than their actual overall unit scores (see Figure 7). In my opinion, the students seemed to be fairly well aware of the input each group member provided. The self/ group evaluation provided an alternate method to get feedback on the efforts of each group member.

Figure 7 - Overall Unit Scores By Year

UNIT SCORES	TOTAL	FEMALE	MALE
92 - 93	73	77.1	68
93 - 94	78.8	80.1	78.4
94 - 95	75.2	77.1	73.3
95 - 96	70.1	69.6	70.6



The comparison between Figure 6 and 7 was to show the relative perception of the students' effort with their actual scores. The data makes it appear the Rotational Learning model was unsuccessful when the scores from 92-93 and 93-94 are compared with 94-95 and 95-96; the years the Rotational Learning Model was implemented. The comparison of the data from year to year contains too many variables. The model was successful however, if you compare the performance levels of the students individually. This makes it important to look at the improvement of the students within each year. This will be discussed further in the Discussion and Conclusion section and Figures 7, 8, 9, and 10.

DISCUSSION AND CONCLUSIONS

The Rotational Learning model appeared to be an effective method of teaching unit objectives. The pretest was an important part of the unit as it provided the student with a preview of the unit objectives and allowed them opportunity for self evaluation. The pretest also provided a baseline from which the improvement of objective mastery could be measured. Although the instructor's traditional method of teaching was incorporated into the unit for comparison purposes, it was an effective tool for improving the students' understanding of the objectives. The mid test scores for the 1994-95 and the 1995-96 school years showed an improved understanding of the objectives. Compared with pretest scores some learning was taking place. As the unit was carried out it became evident the students needed the traditional portion of the unit as an introduction to the objectives. I do not believe Rotational Learning would have been successful without this introduction.

Evaluation of the Rotational Learning Model was different from the original plan. The original intent was to compare test scores from year to year to demonstrate the effectiveness of the model. The comparison of four years of post test and overall unit data suggests the Rotational Learning Model was not effective (see Figures 7 and 8).

One must be aware of the large number of variables, from four years of study. The four years of data represents a sampling of four different groups of students using three methods of teaching. The overall unit scores for 1992-93 were based on the instructors traditional methods. The 1993-94 data utilized only part of the Rotational Learning Model activities (see Figure 9). The "Other" includes worksheets, the research paper and the video presentation. Rotational Learning was not completely in place until the 1994-95 school year.

Figure 8 - Post Test Scores By Year

POST TEST	TOTAL	FEMALE	MALE
92 - 93	73.3	78.4	67.2
93 - 94	75	76.5	72.9
94 - 95	83.3	84.7	82
95 - 96	66.5	63.7	70.3

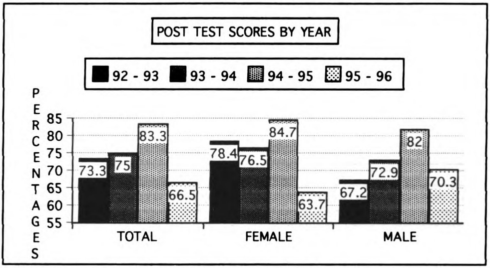


Figure 9 - Breakdown By Year Showing Percentage of Overall Unit Grade

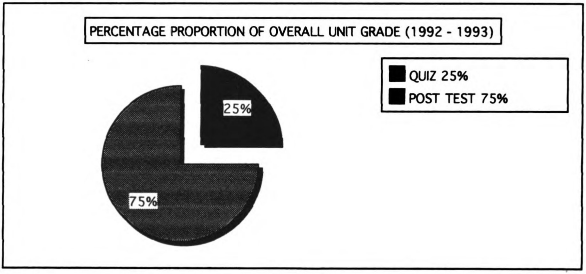
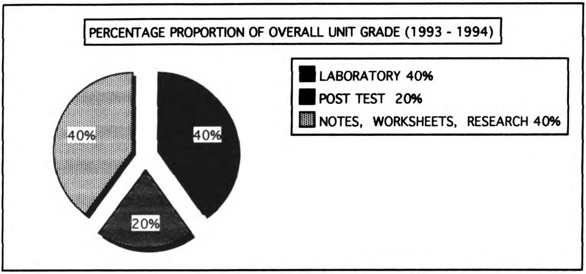
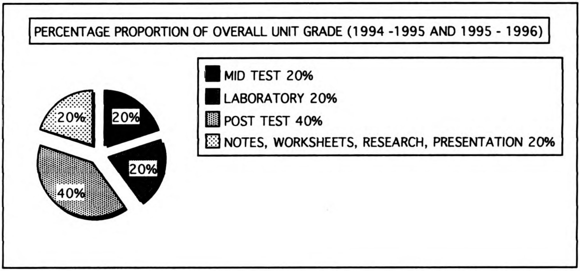


Figure 9 (continued)



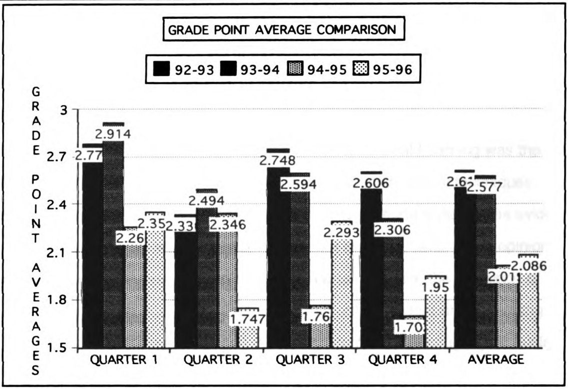


In an attempt to compare data from year to year it was necessary to put the scores in context. A compilation of grade point averages of students for the four years (see Figure 10) showed the year to year differences was probably related to the students' academic abilities. The school years; 94-95 and 95-96 were the years when the Rotational Learning Model was finally in place. The comparison of data from year to year suggests the model was not effective until you compare the lower grade point averages with the lower post test and overall unit scores from the corresponding years (see Figures 8, 9 and 10). The

92-93 and 93-94 data shows higher grade point averages (see Table 10) and higher overall unit and post test scores (see Figures 8 and 9).

Figure 10 - Grade Point Average Comparison By Quarter

	QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4	AVERAGE
92-93	2.778	2.336	2.748	2.606	2.617
93-94	2.914	2.494	2.594	2.306	2.577
94-95	2.264	2.346	1.764	1.702	2.019
95-96	2.355	1.747	2.293	1.95	2.086



The data most relevant to the study was gathered from 1994-95 and 1995-96. This data showed improvements in scores from the beginning to the end of the unit. The pretest and mid test score comparison showed an improvement of 28.4% and 35.2% for the 1994-95 and 1995-96 school years respectively. Even though there was noticeable improvement, it was obvious the students needed more work with the Life Processes unit objectives. The Rotational Learning portion of the unit was considered effective, although the 28 improvement in scores from the mid test to the post test were not as large as the improvement in scores from the pretest to the mid test. The data shows an increase in understanding by 18.4% and 8.7% during the 1994-95 and 1995-96 school years respectively (see Figures 3 and 4).

It should also be noted that there are many advantages to the Rotational Learning model that were not measured quantitatively. I was convinced that Rotational Learning was effective based on the use of other evaluation tools. During the exit interviews many students expressed that they enjoyed learning this way and their understanding of the objectives was greater because of it. Data from the self/ group evaluation and the overall unit scores helped confirm this (see Figures 6 and 7).

Probably the most effective aspect of the Rotational Learning was the repetition of the unit objectives through a variety of instructional techniques. Once I had a better understanding of the students' learning styles it was evident that different activities worked better for different students. Also in my opinion, because we use several learning styles to a certain degree, the repetition of objectives with varied teaching techniques reinforced student understanding. The Rotational Learning used each of the four dominant learning styles outlined in the Introduction.

The **Concerete-Sequential** learners should have done well with my traditional methods of teaching and the note taking rotation in the Rotational Learning portion. It was my intent to have all expectations clear and to the point, which would make sense to the **Concrete-Sequential** and **Abstract-Sequential** learners. The **Abstract Sequential** learners probably enjoyed the laboratories because they required the students to analyze ideas and use the facts to make conclusions. The **Abstract-Random** learners were probably the happiest about working in cooperative learning groups, because they maintain friendly relationships with everyone whenever possible. They like to personalize learning and probably liked the opportunity to expand on their interest areas in the library research. Those learners who are **Concrete-Random** tend to contribute unusual and creative ideas. This probably made them the best partners in the cooperative learning groups, until it came time to write the research paper. It also makes sense to them to use real life situations to learn, which is why they tended to like the hands on/ minds on activities in the Rotational Learning portion of the unit. One **Concrete-Random** individual said they enjoyed the See The Equation/ Be The Equation activity (see Appendix G) and it helped them better understand the two processes of photosynthesis and respiration.

The unit was effective from the instructors perspective . It allowed the teacher to become a facilitator and help the students develop their personal understanding of the objectives. The students became actively involved in learning instead of being passive learners. The instructor to monitored the students' progress as the unit progressed instead of waiting for test results when it was too late to help students.

The preparation for each lab rotation was somewhat more demanding than traditional laboratory activities. It was evident that the time spent setting up each of the four laboratory activities was well worth it when the students were working in the laboratory. The design of the laboratory activities allowed the student groups to work through the problem at hand without the instructor leading them through it step by step. Written with the scientific method in mind, the activities helped to develop laboratory skills and scientific thinking that could be applied to everyday problem solving.

Even though I believe the Rotational Learning model was more effective than the traditional styles of teaching, there were some aspects that needed improvement. The area of greatest concern is the rotation of the laboratory activities. I am not completely comfortable with the fact that each learning group experiences only one of the four laboratory activities. Ideally, all students should experience the laboratory activities first hand. The original intent was to have each learning group be responsible for teaching the basic concepts of the laboratory to their classmates. However, this is counter productive to the unit design. The reason for Rotational Learning in the first place was to allow the students to develop personal understanding of the objectives by doing hands on/ minds on activities.

Based on the overall design of the class, only two units can be taught each quarter. This leaves approximately four and one half weeks for each unit. Twenty one days are required to teach the unit as it was designed for the thesis study (see Appendix A). An additional six days would be necessary to have all cooperative learning groups conduct each of the four laboratory activities. Two problems are evident in trying to do this. One is the use of time devoted to other units. The second problem involves fitting the laboratory activities into the rotation so the number of student groups in the laboratory at one time are limited.

The problem of time constraints is an important factor in that the K-12 science curriculum is aligned to have certain objectives taught each year. It has become the responsibility of each grade level teacher to complete a minimum number of objectives. At the present time, it is difficult to do this with the units taught as they are. Perhaps by implementing the Rotational Learning model in the other units, time would be used more efficiently.

Based on information from the exit interviews, many students believed the time allowed for library research was not sufficient. One solution might be to rotate the learning groups through the laboratory and library on a three day rotation system. This would allow more time for library and laboratory research.

The overall evaluation of the Rotational Learning model is a positive one. Both the quantitative and qualitative results supported this method of teaching science objectives to eighth grade students. Based on this improved success with the Life Processes unit, the plan is to use the Rotational Learning model in other areas of the science curriculum.

APPENDICES

APPENDIX A

APPENDIX A

<u>Lesson Plans</u>

Day One: (Monday)

1. Take Pretest
2. Exchange and grade Pretest

Day Two: (Tuesday)

1. Distribute and preview objectives.
2. Students identify key terms from objective list.
3. Students develop a vocabulary list from key terms on objective sheet.

Day Three :(Wednesday)

1. Balancing Equations worksheet.
2. Ball and Stick models to review atoms and molecules.
3. Home work.. Complete Balancing Equations worksheet.

Day Four: (Thursday)

1. Correct Balancing Equations worksheet.
2. Comparison of Photosynthesis and Respiration worksheet.

Day Five: (Friday)

1. Correct Comparison of Photosynthesis and Respiration worksheet.
2. Photosynthesis and Respiration filmstrip with worksheet.
3. Correct Photosynthesis and Respiration filmstrip worksheet..

Day Six: (Monday)

1. Organize cooperative learning groups based on Pretests (one high score, one low score, and two middle scores)
2. Concept mapping activities (individual concept maps)

Day Seven (Tuesday)

1. Concept mapping activities continued (group maps, cooperative groups make one for class presentation)

Day Eight: (Wednesday)

1. Presentation of maps to entire class as Mid Test review.
2. Take Mid Test.
3. Students exchange and grade Mid Test

Day Nine: (Thursday)

1. Introduce and explain Rotational Learning
   a. Learning Stations (labs, note taking, library research)
   b. Record Keeping (time sheets and self / group evaluations)
2. Topic selection (photosynthesis, respiration, fermentation, or biotechnology)

Day Ten: (Friday)

1. Library introduction by Librarian.
2. Begin library research (practice note and bibliography cards)

Day Eleven and Twelve:, (Monday and Tuesday)

Day Thirteen and Fourteen:, (Wednesday and Thursday)

Day Fifteen and Sixteen:, (Friday and Monday)

1. Conduct lab related to topic choice (2 days)
2. Note taking (2 days)
3. Library research (2 days)

Day Seventeen: (Tuesday)

Day Eighteen: (Wednesday)

Day Nineteen: (Thursday)

1. Video presentation
2. Exit interview
3. Audience for presentations (also complete record keeping)

Day Twenty: (Friday)

1. Take Post Test
2. Exchange and grade Post Test

Day Twenty One: (Monday)

1. Test Corrections

2. Enrichment Activity

APPENDIX B

APPENDIX B

Life Processes Pretest

Short Answer

1. Name the two materials for photosynthesis.

2. Name the two products of photosynthesis.

3. Name the two things that must be present in order for photosynthesis to take place.

4. Name the two materials for respiration.

5. Name the three products of respiration.

6. Name the one material for respiration that is not required for fermentation.

Matching

Directions: Place the letter of the definition that best matches the phrase on the line in front of the appropriate number.

____1. Photosynthesis

___2 Respiration

___3. Fermentation

___4. Biosynthesis

___5. Biotechnology

A. The use of the knowledge and processes of living things to benefit humans.

B. The process by which energy is released from food.

C. A food making process.

D. The production of compounds by the life processes of living things.

E. A type of respiration that does not use oxygen to release energy.

APPENDIX C

APPENDIX C

Life Processes : Unit Objectives

Introduction:

The unit will describe concepts and procedures involved with the various life processes: photosynthesis, respiration, fermentation, and biotechnology.

A. Chemical Equations (review)

1. Explain what a chemical reaction is and describe the parts of a chemical equation. This includes reactants and products.
2. Examine a simple chemical equation and tell how many atoms, elements, and compounds are represented.

B. Photosynthesis and Respiration

1. Define photosynthesis as the process that uses sunlight to produce the sugar; glucose.
2. Define respiration as a process by which energy is released from food
3. Compare the net equations for photosynthesis and respiration and explain their reciprocal relationship.

C. Fermentation

1. Define fermentation as a type of respiration in which sugar molecules are broken down without the use of oxygen.
2. Describe fermentation in terms of it's different starting materials and end products.

D. Biotechnology

1. Describe biosynthesis as a process that produces more complex molecules from simple molecules in living things.
2. Define biotechnology as the use of biological knowledge and the life processes for the benefit of humans.

Michigan Essential Goals and Objectives for Science Education

The unit objectives listed above were taken from the test Schools K - 12 Science Curriculum. This document was compiled by a science curriculum committee and is based on the Michigan Essential Goals and Objectives for Science Education. For the readers reference the following M.E.G.O.S.E. objectives were provided. These objectives are those specifically covered in the unit and come from the life science areas only.

Using Objectives

LC3 -- Explain why specialized cells are needed by plants and animals.

LC4 -- Explain how cells use food as a source of energy.

LC7 -- Compare and contrast ways in which selected cells are specialized to carry out particular life functions.

LC9 -- Compare the transformations of matter and energy during photosynthesis and respiration

LO8 -- Describe evidence that plants make and store energy.

LO12 -- Explain the process of food storage and food use in organisms.

LEC8 -- Describe how all organisms in an ecosystem acquire energy directly or indirectly from sunlight.

LEC10 -- Identify some common materials that cycle through the environment.

LEC12 -- Explain how humans use and benefit from plant and animal materials.

LEC17 -- Describe how water, carbon dioxide and soil nutrients cycle through selected ecosystems.

Constructing Objectives

7. Generate scientific questions about the world, based on observation.
8. Design and conduct simple investigations.
10. Use measurement devices to provide consistency in an investigation.
11. Use sources of information to help solve problems.
12. Write and follow procedures in the form of step-by-step instructions, recipes, formulas, flow diagrams, and sketches.

Reflecting Objectives

6. Evaluate the strengths and weaknesses of claims, arguments, or data.
7. Describe limitations in personal knowledge.
8. Show how common themes of science, mathematics, and technology apply in selected real world contexts.

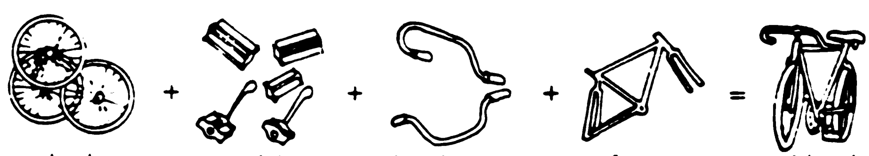
APPENDIX D

APPENDIX D
BALANCING EQUATIONS

You have just bought a box of bicycle parts at a going-out-of-business sale. The box contains three wheels, five pedals, two pairs of handlebars, and one frame. Can you make one or two bicycles from the parts you bought? To find this out, you could draw up a plan using symbols for each of the parts that make up a bicycle. Use the symbol W for wheel, P for pedal, Hb for a pair of handlebars, and F for the bicycle frame .

Next, you need a "formula" for constructing a bicycle. Since a formula should tell the kinds of parts needed, the bicycle formula would contain the symbols for all the bicycle parts—W, P, Hb, and F. A formula should also tell the number of each part necessary to construct something. Because there are two wheels and two pedals in a bicycle, these would be indicated by W_2 and P_2 in the formula. The symbols for a pair of handlebars and a frame would not have a number because there is only one of each in a bicycle. The formula for bicycle, then, would be W_2P_2HbF.

Now you are ready to write the bicycle-making equation. This equation should show the parts that are put together to produce a bicycle. The symbols for each of the parts go on the left side of the equation. The bicycle formula goes on the right side.



wheels + pedals + handlebars + frame = bicycle

W + P + Hb + F = W_2P_2HbF

Figure 2.

To make the equation correct, you need to balance the bicycle-making equation. Begin by comparing the number of wheels on both sides of the equation. Because there are two wheels in the bicycle formula on the right side, you need two wheels on the left side. You should place a 2 in front of the symbol W on the left side of the equation. Why should you also place a 2 in front of the symbol P on the left side?

The balanced bicycle-making equation shows exactly how many of each part you need to build one bicycle:

$$2W + 2P + Hb + F \longrightarrow W_2P_2HbF$$

To find out if you have enough extra parts to build a second bicycle, compare your extra parts with the balanced equation.

Like the bicycle-making equation, chemical equations used by scientists must be balanced. The number of a kind of atom must be the same on both sides of an equation because atoms are neither created nor destroyed in chemical reactions. Balanced chemical equations help scientists in many ways. For example, they help chemists use substances most efficiently. Life scientists can use balanced equations to learn whether a process is happening properly to keep an organism healthy.

You will often be given an equation that is not balanced and be asked to balance it. To do this you must know how to find the number of each kind of atom in a chemical formula.

Questions

1. Carbon dioxide (CO_2) is a gas produced when carbon (C) is burned in the presence of oxygen. The balanced chemical equation for this reaction is shown below. Fill in the number of atoms below.

$$C + O_2 \longrightarrow CO_2$$

_____ carbon atom = _____ carbon atom

_____ oxygen atoms = _____ oxygen atoms

2. Methane gas, CH_4, is a fuel. When it is burned in oxygen, carbon dioxide gas, CO_2, and water, H_2O, are produced. Fill in the number of atoms on each side of the equation as shown. Balance the equation.

$$CH_4 + \_\_\_\_\_ O_2 \longrightarrow CO_2 + 2H_2O$$

_____ carbon atom = _____ carbon atom

_____ hydrogen atoms = _____ hydrogen atoms

_____ oxygen atoms = _____ oxygen atoms

3. You are not permitted to change a chemical formula in order to balance an equation. But you can change the number preceding the formula to balance the equation.
Balance the following equation representing respiration in a cell.

$$\_\_\_\_\_ C_6H_{12}O_6 + \_\_\_\_\_ O_2 \longrightarrow \_\_\_\_\_ CO_2 + \_\_\_\_\_ H_2O$$

Balance the following equation representing photosynthesis.

$$\_\_\_\_\_ CO_2 + \_\_\_\_\_ H_2O \longrightarrow \_\_\_\_\_ C_6H_{12}O_6 + \_\_\_\_\_ O_2$$

On each side of the balanced equation there are:

_____ atoms of carbon, _____ atoms of hydrogen, and _____ atoms of oxygen.

What do you notice about the number of atoms of each element involved in respiration and photosynthesis?

APPENDIX E

APPENDIX E

Comparison of Photosynthesis and Respiration

Directions: The two equations that follow are written using chemical formulas. Identify each equation, then rewrite each equation in complete sentences. Substitute words for each formula in the equations.

1. $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

This equation represents the process of ________________.

Rewrite the equation in words only...________________________

____

____

____

____

____

____

2. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

This equation represents the process of ________________.

Rewrite the equation in words only...________________________

____

____

____

____

____

____

Directions: Complete the following table by providing the answers to the questions at the left.

	PHOTOSYNTHESIS	RESPIRATION
1. What materials are used?		
2. What products are used?		
3. Where does it take place?		
4. What conditions needed?		
5. Energy stored or released?		

APPENDIX F

APPENDIX F

Photosynthesis / Respiration Filmstrip

Directions: Answer each of the following questions from the filmstrip. Do not discuss answers with your neighbors until the filmstrip is over, and you are instructed to do so.

1. Why do living things need energy?
2. What is the major source of all the earth's energy?
3. Photosynthesis does what with energy?
4. Respiration does what with energy?
5. What cell part (organelle) is responsible for photosynthesis?
6. What cell part (organelle) is responsible for respiration?
7. What happens when leaves do not get enough sunlight and the air temperature begins to drop?
8. What materials are taken in during photosynthesis?
9. What products are given off during photosynthesis?
10. What is respiration?
11. What substance is used during respiration to break down glucose?
12. The products of photosynthesis are ___________ and _________.
13. The materials of photosynthesis are ___________ and _________.
14. The products of respiration are ___________ and _________.
15. The materials of respiration are ___________ and _________.

APPENDIX G

APPENDIX G

See The Equation / Be The Equation

Note: The following pages are a written description of a teacher led activity. It is used to reinforce the chemical equations of photosynthesis and respiration. This activity also demonstrates the conservation of matter and demonstrates the reciprocal nature of the processes of photosynthesis and respiration.

Materials for this activity should be prepared ahead of time and are all made from construction paper. The sheets include; 3 plus signs, 1 yields arrow, 1 sunlight, 1 chlorophyll, 1 energy (to demonstrate the energy released during respiration), 6 C's (carbon atoms), 12 H's (hydrogen atoms), 18 O's (oxygen atoms).

Directions: Follow along step by step.

1. Gather students around a long table or open space on the floor.
2. Hand out all atom tags, sunlight tag, chlorophyll tag, energy tag, pluses, and arrow tag to the students (some students may be responsible for more than one tag).
3. The instructor places one plus sign and the yields arrow to give the students a frame work to work within for the materials portion of the equation.
4. Direct the students to discuss and then place their tags in an arraignment that represents the materials needed for photosynthesis.
5. Allow adequate time for discussion and give guidance only as needed.
6. At this time all tags should be arranged in such a fashion that there are six molecules of carbon dioxide and six molecules of water placed before the yields arrow. Discuss the importance of sunlight and chlorophyll and how they are actually not a part of the chemical reaction.

7. Now instruct the students to pick up the atom tags and place them after the yields arrow to represent the products of photosynthesis. Do not move the yields arrow or the sunlight and chlorophyll at this time.

8. At this time all tags should be arranged in such a fashion that there is one molecule of glucose and six molecules of oxygen placed after the yields arrow. Discuss the conservation of matter and review the terms "materials" and "products". Repeat the process as needed, to assure understanding.

9. Challenge the class to move only one tag to get the materials for respiration. Note, the sunlight and chlorophyll tags should be removed first. This is done by moving the yields arrow to the other side of the products of photosynthesis. This would be a good opportunity to explain the reciprocal nature of photosynthesis and respiration.

10. Hide the energy tag in the glucose molecule and ask the students to explain why you are doing this.

11. Now instruct the students to pick up the atom tags and place them after the yields arrow to represent the products of respiration. Do not move the yields arrow at this time.

12. Add the extra plus sign and instruct the students to place the energy tag after the plus sign. Discuss the release of energy and the fact that it is technically not apart of the written chemical equation.

13. Review the two processes and relate them to the carbon dioxide / oxygen cycle. At this time explain how most of the unit relates to this cycle and these processes; answer all student questions.

APPENDIX H

APPENDIX H

Concept Mapping

I. Individual Concept maps

A. Using your text books or any other available source, develop a concept map from the concept word list. You must use all of the concept words, however you may use some, all or none of the transition words. You may add more transition words if you feel it is necessary.

B. This is a homework assignment that is assigned at the end of the traditional style of teaching (prior to the unit mid test).

II. Group Concept Maps

A. The students are placed into cooperative learning groups and asked to complete the following.

1. Compare the completed individual concept maps.
2. Develop one concept map for the group that represents the best of the group.
3. Make sure all concept words are used.

B. The group should prepare an overhead sheet that will be presented to the entire class by a group delegate.

III. Concept and Transition Words

A. Concept Words... carbon dioxide, chlorophyll, chloroplast, energy, glucose, materials, mitochondrion, oxygen, photosynthesis, products, respiration, sunlight, water.

B. Transition Terms... is a, for, takes place in, must be present for, releases, stores.

APPENDIX I

APPENDIX I

Life Processes Mid Test

matching

Directions: Place the letter of the definition that best matches the phrase on the line in front of the appropriate number.

A. Biosynthesis B. Biotechnology C. fermentation

D. Photosynthesis E. Respiration

___1. A food making process that uses the suns energy.

___2. The process by which energy is released from food.

___3. A type of respiration that does not use oxygen to release energy.

___4. The production of compounds by life processes of living things.

___5. Use of knowledge and processes of organisms to benefit people.

short answer

Directions: Complete the following table with the appropriate information.

	photosynthesis	respiration
MATERIALS for	1. 2.	1. 2.
PRODUCTS of	1. 2	1. 2. 3.
SPECIAL CONDITIONS	1. 2.	No special conditions necessary.

Name the material for respiration that is not required for fermentation.

____

APPENDIX J

APPENDIX J

Biotechnology: Yogurt Lab

To The Student:

The purpose of this lab is to demonstrate the practice of food production using living organisms. It should be noted that this lab is one small example of biotechnology.

Introduction:

Yogurt is made from cultured milk as are cheese products. Yogurt , however is not an example of a cheese product because it is curdled by the formation of lactic acid. It has only comparatively recently become popular in the United States, but has been consumed over the centuries in the Near, Far, and Middle East.

Cultured milk is produced by the action of bacteria which changes the lactose (milk sugar) into lactic acid. The curdled milk then may be consumed directly or flavored to mask the somewhat sour taste of the raw yogurt.

The main points of focus for this lab activity are; 1) To make yogurt from milk using live bacterial cultures from commercial yogurt, and 2) to observe changes that occur as a result of the bacterial actions on milk.

Hypothesis:

Knowing that the action of bacteria will produce lactic acid from lactose, form a hypothesis as to what the pH of the milk will be, how it will appear; it's texture, odor, and taste, after 24 hours of incubation at 45 degrees Celsius.

Materials:

600 ml of 2% milk.
`5 ml sample of plain commercial yogurt.
hot plate.
600+ ml container suitable for edible food preparation and capable of being heated to the boiling point of milk.
4 - 300 ml containers suitable for food preparation (i.e. plastic cups).
Aluminum foil to cover the 300 ml containers.
pH paper.
incubator.
refrigerator.
flavoring (optional).

Cautions, Pitfalls, and Hazards:

Since this lab involves the preparation of edible food it is important for the students to use appropriate sanitary techniques, equipment, and material to avoid any health hazards.

Procedures:

1. Add 600 ml of 2% milk to the clean container. Heat the milk to scalding, stir to prevent a skin from forming.

2. Allow the milk to cool to room temperature. Measure the pH by touching one drop of milk onto a piece of pH paper. At this time make observations about the flavor, smell, and texture of the milk. Record all observations on the Student Data Table.

3. Pour 150 ml of the milk into each of two 300 ml containers. Label one container "COOL CONTROL" and label the other "WARM CONTROL".

4. Completely mix approximately 5 ml of commercial yogurt into the remaining milk sample. Pour 150 ml of milk / yogurt sample into each of the two remaining 300 ml containers. Label one container "COOL YOGURT" an the other one "WARM YOGURT".

5. Complete the necessary tests on the yogurt samples as in #2. Record all observations on the Student Data Table.

6. Place the aluminum foil covers on each of the four containers and incubate as follows: Place the "COOL CONTROL" and the "COOL YOGURT" into the refrigerator and place the "WARM CONTROL" and "WARM YOGURT" in the incubator at 45 degrees Celsius for 24 hours.

7. After 24 hours of incubation test all four samples and record all observations on the Student data Page. Make observations on flavor, texture, odor, and pH.

8. If desired, flavor and refrigerate your yogurt. You now may enjoy the product that your little friends; the bacteria (lactobacilli) helped you make.

Conclusion:

Carefully analyze your data and record it on the Data sheet. Explain your reasons for accepting or rejecting your hypothesis. Make sure you provide the evidence that supports your conclusion. Answer the following Conclusion Questions.

1. What changes in pH were observed in the various samples. Compare the samples to each other on both day one and day two. Also compare the pH change for each container from day one to day two.

2. Why must the milk be incubated at 45 degrees Celsius for 24 hours?

3. What accounts for the flavor change in the samples?

4. Name other products that are a result of this or similar processes.

Student Data Page

Day 1	COOL CONTROL	WARM CONTROL	COOL YOGURT	WARM YOGURT
pH				
TASTE				
ODOR				
LOOK				
TEXTURE				

Day 2	COOL CONTROL	WARM CONTROL	COOL YOGURT	WARM YOGURT
pH				
TASTE				
ODOR				
LOOK				
TEXTURE				

APPENDIX K

APPENDIX K

Fermentation Lab

To The Student:

The purpose of this lab is to demonstrate fermentation as a type of respiration that does not require oxygen. You will be able to determine the materials and products of fermentation and make predictions as to the best type of food for the yeast.

Introduction:

Powdered yeast is made up of thousands of single celled organisms called yeast. These tiny fungi need proper conditions to grow and reproduce. In this lab activity you will be growing four different cultures of yeast, supplying each colony with a different type of food source.

Yeast obtains the energy it needs from food by carrying out the process of fermentation. Like respiration, the process of fermentation is an energy releasing process. Fermentation however does not require oxygen to release energy. In other words it is an anaerobic process.

The main points of this lab activity are: 1) Demonstrate the evidence of materials being used in fermentation, 2) demonstrate the evidence of products being released during fermentation, and 3) determine which food type is the best for the yeast (starch, sucrose, protein, or fructose).

Hypothesis:

Form a hypothesis for each of the following. These should be written on day one after the experiment is set up. Remember to write the hypotheses in "If... Then..." statements.

1. Knowing that fermentation is a type of respiration, form a hypothesis as to what type of gas is released as a by-product.

2. Since gas is released during fermentation, write a hypothesis as to how you might predict the sealed bags to be different tomorrow.

3. Predict which food type you think will be best for the yeast _________.

   Why do you think this food type will be the best for the yeast? ______

   ____

   ____

   Now write a hypothesis as to how you will be able to tell the best food type when you check the bags after 24 hours.

Materials:

4 zip lock storage bags

100 ml grape juice / water mixture (50 / 50).

100 ml flour / water mixture (until no more will dissolve).

100 ml sucrose (table sugar) / water mixture (until no more will dissolve).

100 ml gelatin / water mixture (see package directions <i.e. Knox>).

~8 tablespoons yeast mixture.

masking tape to make bag labels.

2 dissecting trays or equivalent to store bags.

Cautions, Pitfalls, and hazards:

It is important that the bags are tightly sealed and that you are not too rough with them. This will prevent unnecessary messes and insure good results. When adding yeast, make sure the gelatin mixture is cool enough as to avoid killing the yeast. When preparing the yeast and water mixture it may be beneficial to begin the cultures a day before, to insure a good culture.

Procedures:

1. Place 100 ml of a different food type / water mixture into each of the four zip lock bags.
2. Place 2 tablespoons of yeast / water mixture into each zip lock bag.
3. Very carefully seal each bag , making sure all air is removed.
4. Carefully swish the mixtures around in the bags to mix the contents thoroughly.
5. Label each bag with a piece of masking tape. Include group and hour identification as well as the food type.
6. Place two labeled bags in each dissection tray and store in the designated location.
7. Answer the hypothesis questions on the previous page.
8. Compare your results on day two with your predictions.
9. Complete the Student Data page and hand work in.
10. Clean up all materials and return to the designated area.

Conclusion:

Carefully analyze the collected data and record it on the Student Data page. Explain your reasons for accepting or rejecting your hypotheses. Provide supporting evidence (use separate paper if necessary).

Student Data Page

Directions: Answer the following questions.

1. How might the size of the bags give you a clue as to which food was best for the yeast?

2. What actually caused some of the zip lock bags to increase in size?

3. List the foods in the experiment; in order, from the best to the worst food for the yeast . Circle the food you predicted to be the best food.

4. Describe how close your prediction was to the actual results.

5. Open each bag and smell the contents. RESEAL THE BAGS. Name at least one product that is produced during fermentation.

6. After discarding the contents of the 4 bags and cleaning up the lab station, graph your results on the bar graph below.

Directions: follow the steps to show the results of your lab.

1. Color in all 5 bars for the best food.
2. Color in only one bar for the food that was worst.
3. color in the bars for the other two in a similar manner.

FLOUR	SUGAR	GRAPE	GELATIN

APPENDIX L

APPENDIX L

Photosynthesis and The Carbon Dioxide Cycle

To The Student:

The purpose of this lab is to demonstrate the Carbon Dioxide / Oxygen Cycle as it relates to the process of photosynthesis.

Introduction:

Bromothymol Blue is an acid / base indicator that will indicate an acidic solution by turning yellowish or by becoming colorless. In this lab activity, carbon dioxide will be blown into a test tube (using a drinking straw) containing water, bromothymol blue, and a sprig of elodea plant. Two other test tubes will contain water and bromothymol blue; one with elodea and one without. Carbon dioxide and water form an acidic solution.

Photosynthesis is a food making process that uses carbon dioxide and water to make glucose (a sugar). The process also releases oxygen as a by-product. This process takes place in living things that contain the green pigment, chlorophyll. The process also requires the light energy of the sun. Respiration on the other hand is a process by which the glucose is broken down (burned) in the presence of oxygen and energy is released. The products of photosynthesis are the materials of respiration and the products of respiration become the materials of photosynthesis. This relationship is what gives rise to the carbon dioxide / oxygen cycle.

The main points of focus for this lab activity are; 1) demonstrate the evidence of materials being used up in the chemical reaction of photosynthesis, and 2) evidence of the products of photosynthesis being used up in the process of respiration.

Hypothesis:

Knowing that bromothymol blue returns to its original blue color as it becomes less acidic, form a hypothesis as to what you predict will happen to the color of each test tube. Remember carbon dioxide is added to one of the test tubes by blowing through a straw.

Materials:

part one

3 corks or rubber stoppers.
3 large test tubes.
1 drinking straw.
1-2 ml bromothymol blue.
1 medicine dropper.

part two

1 photosynthesis / respiration model set.

Cautions, Pitfalls, and Hazards:

It is very important that the corks fit tightly into the test tubes. The test tubes must be placed in an adequate supply of sunlight. It might be beneficial to use grow lights to ensure good results.

Procedures:

part one

1. Label 3 large test tubes -- 1, 2, and 3.

2. Put 25 ml of water into each of the 3 test tubes and add 15 drops of bromothymol blue to each.

3. Cork test tube number 1. This is the control.

4. Using a straw, gently blow into test tube number 2 until the color of the contents becomes yellowish to colorless. place a sprig of elodea plant into this test tube and cork tightly.

5. Place a sprig of elodea plant into test tube number 3 and cork tightly.

6. Make observations every day for the next four days and record all observations on the Student Data page.

part two

Using the photosynthesis / respiration model set, complete the following. Record all data on the Student Data page.

1. Write the balanced equation for photosynthesis.

______ + _______ → _______ + _______

2. With the atom models provided in the model set, construct a model of the reactants (materials) for photosynthesis. When your group has agreed on the results, raise your hand to have the instructor check your work. Do not continue until your work has been approved.

3. Now, construct a model of the products portion of photosynthesis. Remember you will use the same atoms as you used in step 2 (atoms are neither created nor destroyed during a chemical reaction). When your group has agreed on the results, raise your hand to have the instructor check your work. Do not continue until your work has been approved.

4. Answer the related questions on the Student Data page.

5. With the atom models provided in the model set, construct a model of the reactants (materials) for respiration. When your group has agreed on the results, raise your hand to have the instructor check your work. Do not continue until your work has been approved.

6. Now, construct a model of the products portion of photosynthesis. Remember you will use the same atoms as you used in step 2 (atoms are neither created nor destroyed during a chemical reaction). When your group has agreed on the results, raise your hand to have the instructor check your work. Do not continue until your work has been approved.

7. Answer the related questions on the Student Data page.

Conclusion:

Carefully analyze your data and record it on the Data sheet. Explain your reasons for accepting or rejecting your hypothesis. Make sure you provide the evidence that supports your conclusion.

STUDENT DATA PAGE

part one

Directions: Use the space provided below to record your daily observations for each test tube.

	Test Tube 1	Test Tube 2	Test Tube 3
Day 1			
Day 2			
Day 3			
Day 4			

Directions: Answer the following questions about part one.

1. What was the color of test tube number 2 after you were done blowing carbon dioxide into it?

2. What was the color of the test tube containing high levels of oxygen? (hint: test tubes 1 and 3)

3. What was the gas that was given off by the elodea plant that caused the color of test tube 2 to go back to its original color?

4. List some organisms that would benefit from the gas in number 3, if it were released into a pond?

Conclusion

Use this space to record your conclusion and provide supporting evidence for your conclusion.

part two

Directions: Answer the following questions about part two.

1. Write the balanced equation for photosynthesis.

   ______ + _______ → _______ + _______

2. Which of the following organisms carry out the process of photosynthesis? (circle one)

PRODUCERS CONSUMERS DECOMPOSERS ALL THREE

3. Are any atoms created or destroyed (lost or gained) in the process of photosynthesis?

4. What are the two special conditions that must be present for the process of photosynthesis to take place?

5. Write the balanced equation for respiration.

   ______ + _______ → _______ + _______

6. Which of the following organisms carry out the process of respiration? (circle one)

PRODUCERS CONSUMERS DECOMPOSERS ALL THREE

7. Are any atoms created or destroyed (lost or gained) in the process of respiration?

APPENDIX M

APPENDIX M

Respiration and The Carbon Dioxide Cycle

To The Student:

The purpose of this lab is to demonstrate the Carbon Dioxide / Oxygen Cycle as it relates to the process of respiration.

Introduction:

Bromothymol Blue is an acid / base indicator that will indicate an acidic solution by turning yellowish color or by becoming colorless. In this lab activity the bean and / or corn seeds will be soaked overnight to stimulate the germination process. The seeds will be placed into test tubes with wet paper towels to keep them moist and thus will allow germination to continue. The test tube with the seeds will be connected to a second test tube containing a solution of bromothymol blue. This apparatus will be observed over several days to see if there are any color changes in the indicator solution due to the life process of the seeds.

Respiration is a process by which glucose is broken down (burned) in the presence of oxygen and energy is released. Photosynthesis on the other hand is a food making process that uses carbon dioxide and water to make glucose (a sugar). The process also releases oxygen as a by-product. This process takes place in living things that contain the green pigment, chlorophyll. The process also requires the light energy of the sun. The products of respiration are the materials of photosynthesis and the products of photosynthesis become the materials of respiration. This relationship is what gives rise to the carbon dioxide / oxygen cycle.

The main points of focus for this lab activity are; 1) demonstrate the evidence of materials being given off in the chemical reaction of respiration, and 2) evidence of the products of respiration being used up in photosynthesis.

Hypothesis:

Knowing that bromothymol blue becomes yellowish or colorless and returns to it's original color as it becomes less acidic, form a hypothesis about what you expect to happen to the solution color over the next few days. Write a hypothesis for what you expect would happen if the plant grew enough to be able to carry out photosynthesis in the test tube.

Materials:

part one

3 to 4 bean or corn seeds
paper towel
3 medium sized test tubes
2 one hole stoppers
1 stopper without a hole
30 cm of glass tubing with two 90 degree bends
1 to 2 ml bromothymol blue
medicine dropper

part two

1 photosynthesis / respiration model set.

Cautions, Pitfalls, and Hazards

It is very important that the corks fit tightly into the test tubes. Also be very careful handling the glass tubing, it can break and cause severe injury (this is written from personal experience). The wet paper towel that is placed in the test tube with the seeds should not be too wet, or the seeds may mold. The paper towel should not be too dry or your seeds may not sprout. Check your apparatus daily and adjust only if their is a problem. It is important that the apparatus remain sealed to get good results.

Procedures:

part one

1. Lubricate the glass tubing with water to allow the stoppers to slide over them more easily.
2. Place the 3 to 4 soaked seeds into one of the test tubes, along with a piece of wet paper towel. Stopper this test tube with one of the stoppers containing the glass tubing.
3. fill another test tube with water and 15 drops of bromothymol blue.
4. Fill a third test tube (the same size as the one in step 3) with water and 15 drops of bromothymol blue. This is your control. Stopper it with the stopper that does not have hole in it.
5. Allow the apparatus to stand until their is a color change.
6. record all daily observations and data on the Student Data page.

part two

Using the photosynthesis / respiration model set, complete the following. Record all data on the Student Data page.

1. Write the balanced equation for photosynthesis.

   ______ + ______ $\longrightarrow$ ______ + ______

2. With the atom models provided in the model set, construct a model of the reactants (materials) for photosynthesis. When your group has agreed on the results, raise your hand to have the instructor check your work. Do not continue until your work has been approved.
3. Now, construct a model of the products portion of photosynthesis. Remember you will use the same atoms as you used in step 2 (atoms are neither created nor destroyed during a chemical reaction). When your group has agreed on the results, raise your hand to have the instructor check your work. Do not continue until your work has been approved.
4. Answer the related questions on the Student Data page.
5. With the atom models provided in the model set, construct a model of the reactants (materials) for respiration. When your group has agreed on the results, raise your hand to have the instructor check your work. Do not continue until your work has been approved.

6. Now, construct a model of the products portion of photosynthesis. Remember you will use the same atoms as you used in step 2 (atoms are neither created nor destroyed during a chemical reaction). When your group has agreed on the results, raise your hand to have the instructor check your work. Do not continue until your work has been approved.

7. Answer the related questions on the Student Data page.

Conclusion:

Carefully analyze your data and record it on the Data sheet. Explain your reasons for accepting or rejecting your hypothesis. Make sure you provide the evidence that supports your conclusion.

Student Data page

part one

Directions: Use the space provided to record your daily observations and data. This should be done every day for all three test tubes. All group members should observe and help decide what needs to be recorded.

	TEST TUBE 1	TEST TUBE 2	TEST TUBE 3
DAY 1			
DAY 2			
DAY 3			
DAY 4			

Directions: Answer the following questions about part one.

1. Simple observation tells us that the seeds are not green. We can thus conclude that they do not yet contain the pigment ____________. If they do not have this pigment we know they can not carry out the process of ______________.
2. The process these seeds are carrying out is called __________. This process releases the products ______________ and ___________ .

3. The gas released in this process is called _____________ and is responsible for the color change in the bromothymol blue solution.

4. How do we know the carbon dioxide that is responsible for the color change came from the seeds and not simply found in the air?

Conclusion

Use this space to record your conclusion and provide supporting evidence for your conclusion.

part two

Directions: Answer the following questions about part two.

1. Write the balanced equation for photosynthesis.

   ______ + _______ $\longrightarrow$ _______ + _______

2. Which of the following organisms carry out the process of photosynthesis? (circle one)

PRODUCERS CONSUMERS DECOMPOSES ALL THREE

3. Are any atoms created or destroyed (lost or gained) in the process of photosynthesis?

4. What are the two special conditions that must be present for the process of photosynthesis to take place?

5. Write the balanced equation for respiration.

   ______ + _______ $\longrightarrow$ _______ + _______

6. Which of the following organisms carry out the process of respiration? (circle one)

PRODUCERS CONSUMERS DECOMPOSERS ALL THREE

7. Are any atoms created or destroyed (lost or gained) in the process of respiration?

APPENDIX N

APPENDIX N

Library Research Criteria

REQUIREMENTS:

1. A one to two page typed paper.
2. A bibliography page (also typed).
3. Two visual aids for the group presentation.
4. Note cards (minimum of 20 per group).
5. Bibliography cards (one per source used)

JOBS:

Master Writer / bibliographer - this person writes down what the group decides is important and may be needed in the research paper. If everyone in the group takes notes; which is one way the group may decide to do research; the master writer will write the rough draft of the paper using the other members note cards. Good penmanship and good organizational skillsare important.

Editor: - this person is in charge of correcting spelling and grammatical errors, and checking for run on sentences or sentence fragments. This person should be good at spelling and do well in English class.

Typist: - this individual types the final draft of the paper, either on a computer or a typewriter. This person must have access to one of these or be willing to use a school computer at a convenient time.

Visual Aids Coordinator: - this person is in charge of the visual aids for the group presentation. They need to make sure the group has the necessary supplies when needed and to make sure they are completed and ready to go on the day of the presentation. This individual should be creative and somewhat artistic. Good graphing skills may prove to be helpful.

Fifth Person: - If your group happens to have five people , the fifth job will be completing the bibliography. Everyone is expected to help with all jobs!

THE PAPER:

Your paper should begin by identifying the topic you are researching. Your group should also provide a good brief description and explanation of what your topic area is about. The second part of the research paper can cover any branch of the topic that interests you; for example your group may have selected biotechnology and you find the wine industry is interesting to your group. You may choose to focus the majority of your paper on the production of wine. You must however, relate the production of wine to biotechnology. The most important thing is that your group provide plenty of examples and make the paper interesting to read.

BIBLIOGRAPHY:

You must use a minimum of two different types of sources. This means you may use more than one encyclopedia, but then you must also use a book, magazine, periodical, etc. Your textbook may be a good source for information but it will not count as one of your two types of sources, it must however be included on a bibliography card and a bibliography page in your typed paper.

Please refer to the bibliography sample sheet to assure you use the correct format. It should be noted that reverse indentation is used if a bibliography is longer than one line. The Groliers encyclopedia on the computer is referenced as an encyclopedia.

VISUAL AIDS:

Your video presentation will require you to make at least two visual aids. The presentation will be divided between the research paper and your laboratory experience. All group members will be directly and actively involved in the presentation, therefore one persons portion of the presentation may consist of an explanation of the visual aids. Visual aids may include posters, graphs, charts, overheads, data, and products from the labs, etc.

Bibliographies

A bibliography is a standard method for recording where information came from. It is important to be able to prove that the research came from legitimate sources. Use the following forms when recording information for bibliography cards.

I. When working with a BOOK:

A. Authors last name, then first name.
B. Full title underlined.
C. Place of publication.
D. Date of publication.
E. Publisher.
F. Page(s).

II. When working with a PERIODICAL or MAGAZINE.

A. Authors last name, then first name.
B. Full article title "in quotes".
C. Name of periodical underlined.
D. Volume number.
E. Date in (parentheses).
F. Page(s).

III. When working with an ENCYCLOPEDIA.

A. Authors last name, then first name.
B. Full title of article "in quotes".
C. Name of encyclopedia underlined.
D. Date of publication in (parentheses)
E. Volume number.
F. Page(s).

IV. When working with NEWSPAPER ARTICLES.

A. Authors last name, then first name.
B. Full title of article "in quotes".
C. Name of newspaper underlined.
D. Date
E. Section (some newspapers are not divided into sections)
F. Page(s).

A bibliography is a standard method for recording where information came from. It is important to be able to prove that the research came from legitimate sources. Use the following forms when recording information for a bibliography page.

I. When working with a BOOK:

Author's last name, first name, full title underlined. Place of publication, date of publication, Publisher, page(s).

II. When working with a PERIODICAL or MAGAZINE.

Author's last name, first name, "full article title in quotes", Name of periodical underlined. volume number, (date in parentheses), page(s).

III. When working with an ENCYCLOPEDIA.

Author's last name, first name, "full article title in quotes", Name of encyclopedia underlined. (Date of publication in parentheses) volume number, page(s).

IV. When working with NEWSPAPER ARTICLES.

Author's last name, first name, "full article title in quotes", Name of newspaper underlined. Date, Section (some newspapers are not divided into sections) page(s).

APPENDIX O

APPENDIX O

Note Taking Rotation

Introduction: The students will take notes from a variety of sources, including laser disc programs from Optical Data's, Windows On Science, and Macmillan / McGraw - Hill's, Living Things. The students will also take notes from their textbook, Life Science (Merrill, 1993).

I. HOMEWORK -- Students will read the following textbook pages and take notes for homework credit. Upon completion of the reading and note taking each student will complete the textbook worksheet from the Study Guide and Reinforcement booklets (page 15 in each). Read pages: 63 -65, 276 - 280, and page 584.

II. DAY ONE IN CLASS -- Place the Windows On Science laser disc into the laser disc player and push PLAY. Using the remote enter FRAME - 33938 then push SEARCH. Now push the STEP button to advance through frame 33940. Take notes as needed. Continue as follows:

FRAME - 33903 - SEARCH - STEP through 33905.

FRAME - 33898 - SEARCH - STEP through 33900.

FRAME - 33953 - SEARCH - STEP through 33955.

FRAME - 33983 - SEARCH - STEP through 33985.

FRAME - 30354 - SEARCH. Copy the diagram and explain.

FRAME - 30356 - SEARCH. Copy the diagram and explain.

FRAME - 30357 - SEARCH. Copy the flow chart and explain what it shows about photosynthesis and respiration. If you have enough time, begin your homework assignment. The textbook notes and the worksheet are both DUE tomorrow. Day two laser disc notes will be added to today's work and will also be turned in.

III DAY TWO IN CLASS -- Place the Living Things. (side B) laser disc into the laser disc player and push PLAY. Using the remote enter the following: (take notes as needed)

FRAME - 33903 - SEARCH - push PLAY.

FRAME - 33898 - SEARCH - push PLAY .

FRAME - 33953 - SEARCH - push PLAY .

FRAME - 33983 - SEARCH - push PLAY .

FRAME - 30354 - SEARCH. - push PLAY.

FRAME - 30356 - SEARCH. - push PLAY .

Pick up one copy of the Group Note Review worksheet from the instructor. As a group you will need to discuss and answer the questions on the worksheet. This assignment is designed to help all group members better understand the information from the note taking rotation. The group will receive one grade for their work (this is a quiz grade).

Turn all work in from the Note Taking Rotation. This includes; textbook notes and worksheets, individual laser disc notes and the Group Note Review worksheet.

APPENDIX P

NAME ______________________ DATE ____________ CLASS ______________

STUDY GUIDE — Chapter 3

Energy in Cells

Text Pages 63–65

Complete the following sentences using appropriate terms from the textbook.

1. Plants get their energy from the ______________________.
2. The green pigment in plants is called ______________________.
3. Organisms that can make their own food are called ______________________.
4. A food chain always begins with a ______________________.
5. The process by which plants change light energy into chemical energy is called ______________________.
6. All the chemical changes that occur within the cells of an organism is called ______________________.
7. During fermentation, ______________________ and ______________________ are produced.
8. Overworked muscles can still produce energy when oxygen levels are low by the process of ______________________.
9. The metabolism of glucose when oxygen is present is called ______________________.
10. Consumers obtain energy by eating ______________________ and other consumers.

Write the letter of the term that best matches each phrase.

_____	1. energy is given off in the absence of oxygen	a. glucose
_____	2. energy source necessary for photosynthesis	b. chlorophyll
_____	3. causes muscles to tire	c. mitochondria
_____	4. made and stored by plants	d. sunlight
_____	5. obtain energy from producers	e. oxygen
_____	6. traps radiant energy	f. consumers
_____	7. energy can be lost in this form	g. alcohol
_____	8. contain green pigment	h. chloroplasts
_____	9. place where glucose is metabolized	i. water
_____	10. combines with glucose during respiration	j. heat
_____	11. fermentation product in yeast	k. fermentation
_____	12. waste product in respiration	l. lactic acid

NAME ______________________ DATE ____________ CLASS ______________

REINFORCEMENT **Chapter 3**

Energy in Cells

Text Pages 63–65

Answer the following questions.

1. How do producers make their own food? ______________________

2. Fill in the following equation for photosynthesis.

   ______________ + water + carbon dioxide + chlorophyll ——————→

   ______________ + ______________

3. What are the end products of respiration? ______________________

4. What is a food chain? ______________________

5. How does yeast cause bread to rise? ______________________

6. How do your muscles continue to get energy during high levels of activity when there is not enough oxygen? ______________________

Write the letter of the term that correctly answers each question or best completes each statement.

_____ 1. What process occurs in the mitochondria?
  a. fermentation b. photosynthesis c. respiration d. metabolism

_____ 2. The green pigment in plants that traps radiant energy from the sun is called _____ .
  a. glucose b. chlorophyll c. oxygen d. water

_____ 3. During photosynthesis, plants produce glucose and give off _____ .
  a. carbon dioxide b. energy c. oxygen d. water

_____ 4. The energy used by all living things starts with _____ .
  a. producers b. consumers c. respiration d. sunlight

_____ 5. During respiration some energy is lost as _____ .
  a. chemical energy c. heat
  b. radiant energy d. carbon dioxide

_____ 6. Fermentation gives off energy without using _____ .
  a. oxygen b. glucose c. energy d. carbon dioxide

_____ 7. When muscles are overworked, soreness is caused by a buildup of _____ .
  a. glucose b. carbon dioxide c. lactic acid d. energy

NAME ______________________ DATE ____________ CLASS ____________

REINFORCEMENT — Chapter 12

Photosynthesis and Respiration

Text Pages 276–281

Answer the following questions using information from the textbook.

1. a. What causes the stomata on leaves to open? ______________________

   b. When are the stomata usually open? ______________________

   c. What happens when stomata open? ______________________

2. Why do plants need a lot of water? ______________________

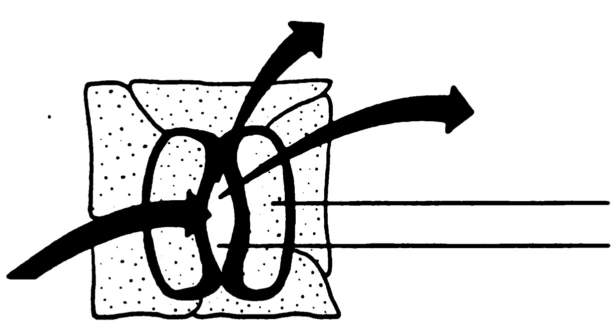
3. Write the chemical equation for photosynthesis. Label the chemical compounds.

4. How do we depend on photosynthesis? ______________________

5. What is respiration? ______________________

6. Write the chemical equation for aerobic respiration. Label the chemical compounds.

Label the following diagram of an opening in a leaf. Draw arrows to show the movement of water vapor, carbon dioxide, and oxygen. Label the guard cells and the stoma.



NAME ____________________ DATE ____________ CLASS ____________

STUDY GUIDE — Chapter 12

Photosynthesis and Respiration

Text Pages 276–281

Write the correct term from the textbook next to each description.

____________ 1. control size of stoma opening

____________ 2. enters through stomata

____________ 3. released through stomata

____________ 4. loss of water vapor

____________ 5. masked by green pigments in the spring and summer

____________ 6. traps light energy during photosynthesis

____________ 7. sugar formed during photosynthesis

____________ 8. gaseous product of photosynthesis

____________ 9. process that releases energy

____________ 10. process that stores energy

Complete the following sentences using appropriate words from the textbook.

11. Leaves have more ____________ on the lower surface.

12. More water is lost through ____________ than is used during photosynthesis.

13. Water is lost in the form of ____________.

14. Photosynthesis is a process in which energy is ____________.

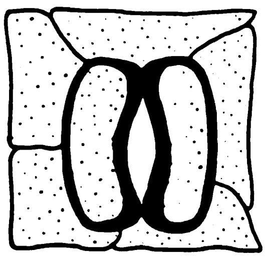
15. $C_6H_{12}O_6$ is the chemical formula for ____________.

16. Photosynthesis occurs only in cells containing ____________.

17. Water is split by energy from ____________.

18. During photosynthesis, plants remove ____________ from the air.

19. ____________ occurs in all cells of all organisms.



a stoma

APPENDIX Q

APPENDIX Q

Group Note Review

Directions: Discuss each question with your group. When the group comes to a consensus on what the correct answer is, circle the correct response.

1. The two materials or reactants of respiration.

   A. sunlight and chlorophyll　　B. photosynthesis

   C. water, carbon dioxide, and energy　　D. glucose and oxygen

2. The use of knowledge and processes of living things to benefit humans.

   A. biotechnology　　B. respiration

   C. fermentation　　D. photosynthesis

3. The two things that must be present for photosynthesis.

   A. minerals and vitamins　　B. soil and air

   C. sunlight and chlorophyll　　D. glucose and oxygen

4. Respiration that does not require oxygen to release energy.

   A. biotechnology　　B. respiration

   C. fermentation　　D. photosynthesis

5. The products of photo synthesis are...

   A. water and oxygen　　B. glucose and oxygen

   C. carbon dioxide and water　　D. glucose and water

6. The three products of respiration are ...

   A. sunlight, water, and soil　　B. glucose, oxygen, sun.

   C. water, carbon dioxide, and energy　　D. water, salt, and soil

7. A food making process.

   A. photosynthesis　　B. mitosis

   C. fermentation　　D. respiration

8. A process by which energy is released from food.

   A. photosynthesis
   B. meiosis
   C. respiration
   D. biotechnology

9. The production of compounds by living things.

   A. photosynthesis
   B. biosynthesis
   C. meiosis
   D. mitosis

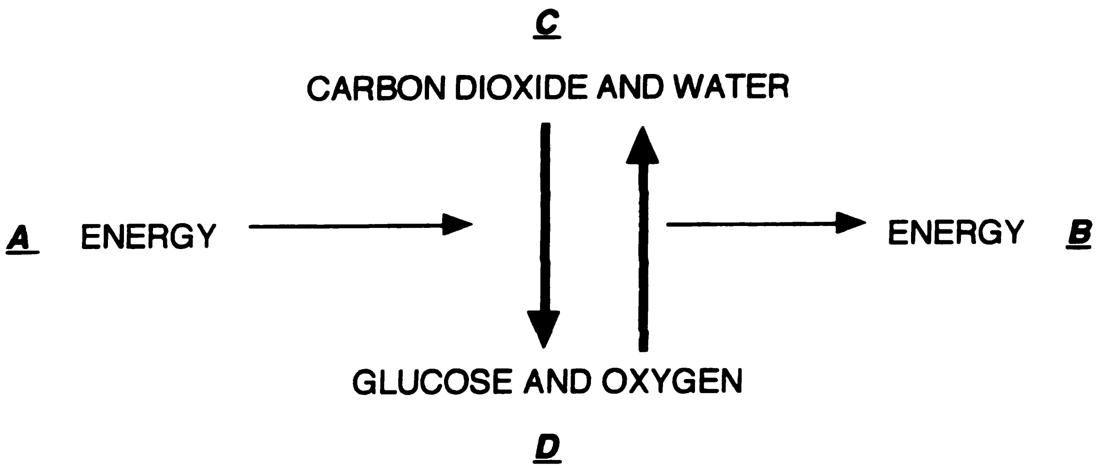
10. The two materials or reactants for photosynthesis are...

   A. water and carbon dioxide
   B. sunlight and glucose
   C. glucose and energy
   D. meiosis and mitosis

Directions: Complete the following sentences by filling in the blanks with the appropriate word or words.

1. The two conditions that must be present in order for photosynthesis to take place are __________ and _____________.
2. A food making process that uses water and carbon dioxide to make glucose is called ________________ .
3. The two materials for photosynthesis are _______ and _______________ .
4. The two products of photosynthesis are _________ and _______.
5. The two materials of respiration are _________ and _______.
6. The three products of respiration are ________, ________ , and ________ .
7. Biosynthesis is the production of ___________ by living things.
8. Biotechnology is the use of ___________ and the processes of living things to benefit ________.
9. Fermentation is a type of __________________ that does not use oxygen to release ____________ .
10. Respiration is the process by which __________ is released from ______ .

Directions: Use the letters A, B, C, or D to answer the following questions about the diagram.



_____ 1. The materials of respiration.

_____ 2. The products of respiration.

_____ 3. The materials of photosynthesis.

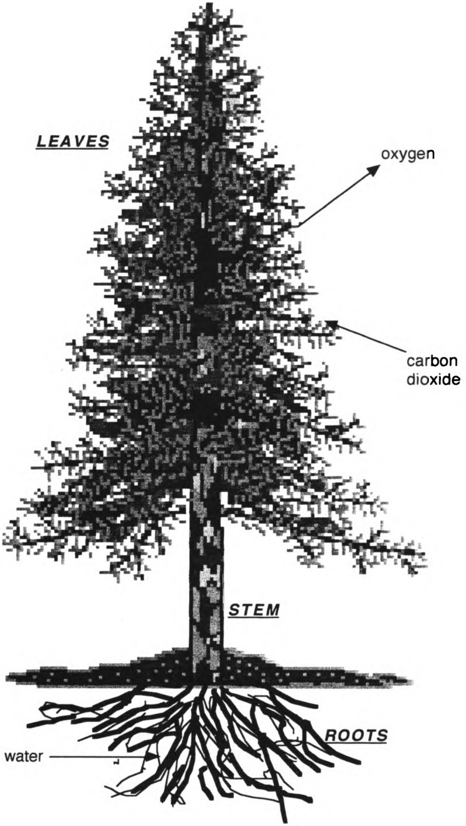
_____ 4. The products of photosynthesis.

_____ 5. Energy in photosynthesis.

_____ 6. Energy in respiration.

Directions: Fill in the table with the appropriate photosynthesis terms from the diagram of the plant.

PART	FUNCTION
________	1. ________________________ 2. Gas exchange (O_2 and CO_2).
STEM	1. Stores food. 2. ______________.
ROOTS	1. Anchors plant. 2. ______________. 3. ______________.


LEAVES
oxygen
carbon
dioxide
STEM
ROOTS
water

APPENDIX R

APPENDIX R

Unit Time Sheet

Name: ________________ Topic: ______________ Group # __________

DATE	TIME OF DAY	TYPE OF WORK DONE	TIME

TOTAL TIME SPENT ON UNIT IN AND OUT OF CLASS ______________

APPENDIX S

APPENDIX S

Group/ Self Evaluation

Directions: Write each group members name in each category and evaluate each member of the group, including yourself. 4 = MOST INPUT POSSIBLE, this means, that individual pulled their own weight. 1 = LITTLE OR NO INPUT, this means the rest of the group had to make up for what this person did not do. For an individual that was absent, write the word ABSENT across the numbers instead of evaluating them that day.

LAB DAY ONE	(least input)			(most input)
____________	1	2	3	4
____________	1	2	3	4
____________	1	2	3	4
____________	1	2	3	4
____________	1	2	3	4

LAB DAY TWO	(least input)			(most input)
____________	1	2	3	4
____________	1	2	3	4
____________	1	2	3	4
____________	1	2	3	4
____________	1	2	3	4

NOTE DAY ONE	(least input)			(most input)
____________	1	2	3	4
____________	1	2	3	4
____________	1	2	3	4
____________	1	2	3	4
____________	1	2	3	4

NOTE DAY TWO	(least input)			(most input)
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4

RESEARCH DAY ONE	(least input)			(most input)
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4

RESEARCH DAY TWO	(least input)			(most input)
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4

PRESENTATION	(least input)			(most input)
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4
____________________	1	2	3	4

APPENDIX T

APPENDIX T

Video Presentation Criteria

REQUIREMENTS:

1. A four to five minute presentation.
2. All group members speak.
3. Two visual aids (minimum) explained during the presentation.
4. Summarize the research paper (do not read it to the audience).
5. Discuss the lab procedures and results.

JOBS:

Present summary of research paper - This person should summarize the findings of the library research paper. They should not read the paper!

Present lab procedures - This person should summarize the purpose and basic procedures of the laboratory exercise. The group's hypothesis should be described and rationale should be given for the group's hypothesis. Those students who did not do this particular lab activity should have an understanding of what happened in the lab

Present lab results - This person should explain the outcome of the laboratory exercise and give the results and explanation of the collected data. They should explain why the group's hypothesis was accepted or rejected. Don't forget to provide evidence for your conclusion.

Explain visual aids - This person is in charge of explaining the visual aids for the presentation. They should make sure the other students understand the significance of the visual aids. In other words, don't just have visual aids for looks; they should help the delivery of the presentation.

Fifth Person - If your group has a fifth person, they should assist in one of the above areas. Remember all group members must be a part of the presentation in order for the group to receive full credit.

APPENDIX U

APPENDIX U

Exit interview Questions

part one: group understanding of objectives

Directions: Discuss each of the following questions with your group members. When your group has reached a consensus give your answer to the instructor.

1. What is the definition for biosynthesis? (break the word down into parts and give a definition in your own words).

<BIO = LIFE and SYNTHESIS = TO PUT TOGETHER OR MAKE>
(or biosynthesis is the process of producing more complex molecules from simple ones, in living organisms)

__ OBJECTIVE MET __ OBJECTIVE NOT MET

2. If biosynthesis is a process of producing more complex molecules from simple ones... which are examples of biosynthesis?

PHOTOSYNTHESIS...(YES; H_2O and $CO_2 \rightarrow C_6H_{12}O_6$)
RESPIRATION..............(NO; $C_6H_{12}O_6$ is broken down)
FERMENTATION..........(NO / YES; $C_6H_{12}O_6$ is broken down, but products?)

__ OBJECTIVE MET __ OBJECTIVE NOT MET

3. What is biotechnology? (break the word down into parts and give a definition in your own words).

<BIO = LIFE and TECHNOLOGY is the use of scientific knowledge and processes that benefit humans> (or the use of knowledge and processes of living things to benefit humans)

__ OBJECTIVE MET __ OBJECTIVE NOT MET

4. Knowing that fermentation is a type of respiration; tell how the two processes are alike and how they are different.

<Alike -> both break down $C_6H_{12}O_6$ to release energy>
<different -> respiration uses O_2 but fermentation is anaerobic>

__ OBJECTIVE MET __ OBJECTIVE NOT MET

part two: group input about rotational learning

Directions: Think carefully about each of the following questions and give your honest, initial response.

1. How was this unit different from any other unit in science?

--EASIER / MORE DIFFICULT?

--MORE OR LESS INTERESTING?

--OTHER COMMENTS?

2. Would you like to learn this way again?

--WHY OR WHY NOT?

--OTHER UNITS?

--OTHER SUBJECT AREAS?

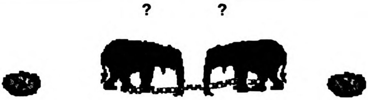
--WHAT WOULD YOU CHANGE?

part three: group evaluation

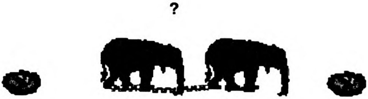
Directions: Each group member will have an opportunity to respond. Which of the following best represents how your group worked to accomplish the given task? Explain how and why you feel that way?

THE NEED

A



B



C

D

APPENDIX V

APPENDIX V

Life Processes Post Test

matching

Directions: Place the letter of the definition that best matches the phrase on the line in front of the appropriate number.

A. Biosynthesis B. Biotechnology C. fermentation

D. Photosynthesis E. Respiration

___1. A food making process that uses the suns energy.

___2. The process by which energy is released from food.

___3. A type of respiration that does not use oxygen to release energy.

___4. Production of compounds by the life processes of living things.

___5. Use of knowledge and processes of organisms to benefit people.

short answer

Directions: Complete the following table with the appropriate information.

	photosynthesis	respiration
MATERIALS for	1. 2.	1. 2.
PRODUCTS of	1. 2	1. 2. 3.
SPECIAL CONDITIONS	1. 2.	No special conditions necessary.

Name the material for respiration that is not required for fermentation.________

short answer

1. Name the two materials for photosynthesis.
2. Name the two products of photosynthesis
3. Name two things that must be present for photosynthesis to take place
4. Name the two materials for respiration.
5. Name the three products of respiration.
6. Name the one material for respiration not required for fermentation.

matching

Directions: Place the letter of the definition that best matches the phrase on the line in front of the appropriate number.

____1. Photosynthesis

___2 Respiration

___3. Fermentation

___4. Biosynthesis

___5. Biotechnology

A. Use of the knowledge and the processes of living things to benefit humans.

B. The process by which energy is released from food.

C. A food making process.

D. The production of compounds by the life processes of living things.

E. A type of respiration that does not use oxygen to release energy.

Extra Credit

What two life processes are involved in the Carbon Dioxide / Oxygen Cycle? ________________________ and ____________________________

As a distance runner can no longer supply enough oxygen to his / her muscles, the body will start breaking glucose down by an anaerobic process called _________. Often times sore muscles may result, this is caused by a build up of _______________.

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