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Appendices

Appendix 1 Questionnaire for Biology Teachers

Dear teacher,

In this questionnaire, you are requested to express your candid opinion on the effect of In-service professional training for the implementation of Biology curriculum concerning teaching strategy, integration of subject content as well as availability and utilization of instructional materials in your school. I assure you that your responses will be used strictly for research purposes and the information given will be treated confidentially.

The questionnaire is divided into two sections, please be sincere in your reply and respond to all questions as the study is not intended at knowing about each school or an individual, but rather to find out ways of solving the identified problems.

Section A: Please supply the information below:

1. Name of School:
2. Sex: male female
3. School Type: who sponsors the School? (Tick off one) private or the public
4. Your Academic/Professional Qualifications:
.....
5. Tick off your area of Specialization Biology Chemistry Physics Others (specify)
6. Teaching Experience (tick one) 0-2 years 3-5 years over six years .
7. Do you prepare your scheme of work directly in the order it is listed in the Biology Core Curriculum? Yes No
8. From the following indicate problems that can be identified with the arrangement of the contents in the Biology Curriculum you are using currently (Please tick two).
 - Some of the suggested topics treated at the middle school would have been suitable for students in their last year of secondary school.
 - The learning of topics such as diffusion and osmosis poses serious problems and as such should be treated at another level.
 - Most of the chapters do not present Science as integrated and not sequentially arranged for effective teaching and learning.

- The arrangement of the course content does not provide a sound basis for laying the adequate foundation for subsequent special study in Science at tertiary level
 - Some of the suggested activities should have emphasized on using locally made materials and reflect what is available in the student's immediate environment.
9. Which of the following teaching strategies do you adopt for teaching during your lessons in the classroom? (tick off one) (a) Student-Based approach (b). Lecture Method (c). Discussion Method (d). Field trip (e) Demonstration (f) Questioning Method
10. Is the time allocated for teaching in your school adequate to cover the course content for the year? Yes No .
11. Do you have a problem teaching any topic in your subject area? Yes No .
12. If your answer to question 11 is "Yes" please indicate the topic.
Topic: plant science Heredity/Genetics Human Biology
specify.....
13. Do you confirm that your School has necessary if not all instructional materials, equipment, and teaching facilities required for effective teaching of Biology Yes No ?
14. How often do you use instructional materials available in your school? (tick one)
(a) Frequently (b) sometimes (c) Not at all .
15. Have you ever attended any Seminar/Workshop about teaching Biology? Yes No
(tick one). If yes, what are the activities that have been carried out during the workshop you have found they make your lesson more interesting to the students in your School?
.....
16. If given the opportunity, are you willing to attend a workshop/Seminar at your expenses? (tick one) Yes No Kindly state the reason why?
.....
17. When compared to other schools, my school has (a) Most (b) Some (c) Few
instructional materials and infrastructures for effective teaching and learning of biology (tick one).

Section B: To know your opinion, please indicate your level of agreement or disagreement by ticking off (✓) in the appropriate column.

	CONTEXT VARIABLE	SA	A	N	D	SD
1.	The objectives of the Biology as spelled out in the Core Curriculum are clearly stated and achievable.					
2.	The order in which topics are put in the Biology Curriculum facilitates the efficient teaching of this course.					
3.	The prescribed content for each year of study is adequate because it is arranged according to complexity. It becomes more detailed as the year progress.					
4.	The selected content takes the age of the students into consideration for effective implementation.					

	INPUT VARIABLE	SA	A	N	D	SD
1.	Depending on the teaching resources available, most of the time I select topics for teaching without strictly following the order suggested in the Core Curriculum.					
2.	I feel that the Government should make more efforts to supply more teaching and laboratory materials to schools for effective Biology teaching.					
3.	The inclusion of science allowance for teachers by the Government is a way of encouraging more people to specialize in science-related courses.					
4.	More Teachers should be sent for In-service training to encourage them to perform better in their work.					
5.	I enjoy attending seminars/workshops for self-improvement.					

	PROCESS VARIABLE	SA	A	N	D	SD
1.	Teaching science by discovery approach is adequately reflected in the Biology course.					
2.	Science teachers must make their students see the course as an investigation of nature within the environment.					
3.	In Libya, teachers of Sciences are expected to use local examples to foster learning and enable the students to know about their environment through improvisation.					
4.	Teaching approaches such as Lecture Method and Field Trip motivate students to learn more than Activity Oriented and the student-based approach recommended for the course.					

	PRODUCT VARIABLE	SA	A	N	D	SD
1.	One of the goals of biology is to enable students to gain the					

	concepts of the fundamental unity of science from their daily life routine.					
2.	In Libya, students who study Biology are expected to develop certain skills such as observation, investigation. synthesizing etc.					
3.	The kinds of activities suggested for use in the core curriculum permit students to use scientific techniques later in life for the fulfillment of the National philosophy of self-reliance.					
4.	The course objectives provide for satisfactory achievement on national needs and aspirations.					
5.	Through Biology courses, students have an adequate foundation for subsequent special study at University.					



Appendix 2 Interview Questions Adopted and modified from (Park 2005)

Backgrounds to biology Teaching

1. Can you tell me about your background in biology and science teaching?
2. What do you see as your strong points in the teaching practice of Biology?
3. In which areas do you feel relatively weak in your teaching practice?
4. What is biology teaching in your mind?
5. Can you describe what your biology classes look like?
6. What are the characteristics of your biology teaching?
7. Can you tell me what you think are the reasons for learning Biology at secondary school?
8. What are your goals for your students?
9. What do you think makes Biology difficult for students?
10. How would you help to solve the difficulties students have in learning biology?
11. What can make the study of biology easier for students?
12. Can you tell me about the classes you are teaching?
13. How do you decide what to teach and what not to teach?
14. How do you decide when to move from one concept to another?
15. What is your opinion on students' interaction in biology's lab?

Planning for a Class (or a Unit)

1. Have you taught this unit before?
2. How comfortable are you with the subject matter developed in this unit you are teaching?
3. What are your goals for this unit?
4. What subject matter or concepts do you think students might have difficulties with? Why do you think so?
5. What kinds of students' misconceptions associated with this unit have you noticed?
6. How would you help them correct their misconceptions?
7. What kinds of things do you take into consideration in planning this unit?
8. How do you create individual goals or objectives for each topic or class compared to creating for units?
9. How do you plan to assess student learning in this unit?

10. What evidence are you looking for to make sure that students have managed to address the goals for the lessons?

Retrospective Interview on Teaching a Class (or a Unit)

1. Do you use the lab for teaching biology? If yes how often do you use the lab?
2. Have you ever used the 5Es technique to teach biology before? If no, which technique do you use?
3. What changes will you bring to this unit next time you are going to teach? Why?
4. What do you think was the most effective teaching moment in teaching this unit?
5. What showed you that students were effectively learning?
6. Based on specific examples of representations, strategies, activities, etc. used by the teacher during teaching the unit:
 - Why did you decide to use this?
 - Did you prepare this activity before your students practice it in a biology lab? If yes, do you think this change as a result of participating in a training programme?
 - What evidence did you have that this worked?
 - What counts as a high level of accomplishment for this activity?
 - How did you know whether it was effective?

Changes Occurred after the training programme

1. Have you recently made any change in ways of representing Biology subject matter?
 - If yes, why?
 - How has the training programme influenced these changes?
2. Have you recently made any changes in ways of interacting with students?
 - If yes, why?
 - How has the training programme influenced these changes?
3. Have you recently made any change in teaching planning, classroom activities, or classroom management skills?
 - If yes, why?
 - How has the training programme influenced these changes?
4. Have you recently made any change in your ways of assessing students' learning?
 - If yes, why?

- How has the training programme influenced these changes?
5. Have you recently experienced your subject matter knowledge is deepen or broaden?
 - If yes, why?
 - How has the training programme influenced these changes?
 6. Have you noticed any changes in student performance after your involvement with the training programme?
 7. Are there things at the local/school/state level that influence the way you teach?
If yes, give some examples.

Teachers understanding of Students' thinking of the content

1. From your experiences, how do you describe student's characteristics in the biology classrooms? (Cognitive, affective, and social aspects).
2. How do you know when your students understand a concept?
3. What are the instructional challenges you encountered that were caused by your students' temper? How did you handle those challenges?
4. How do you take look at students' temper in your teaching?
5. How do you think your students come to believe in their minds that they understand something?
6. Are there any other comments that you would like to add?



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Appendix 3 Teacher selected interviews- (example teacher 1)

What is your background in teaching science?

At secondary school, I studied basic sciences. At high school, I did not study science education but I loved Biology thanks to my teacher. Then, I studied at the Faculty of Science to specialize in animal science and I graduated in 2000. After graduating I enrolled in a training course in one of the hospitals. When I finished training I was employed in the laundry center of the kidney and I worked there for two years before working in a laboratory for special medical analysis. Then after, I got a job as a teacher because in Libyan society teaching is acknowledged as the most appropriate for women. Therefore, since 2004 or for almost 13 years I have been teaching general biology and other related subjects such as environmental microbiology etc. at the secondary school level. At the time the government has forbidden non-qualified teachers to teach I worked in a private school for four years and then I have been called back again to work in public schools.

What do you think are the positive aspects of your teaching of biology?

Teaching in the laboratory is one of the most interesting aspects for both my students and me. In the lab, I noticed that even the weak students were active and capable of performing well in the way I did not expect them to. Meanwhile, teaching outside of the lab, in a normal class, some students are bored and not interested in learning this was a mixed school with both boys and girls students, many times boys want to do things in their own way mostly when they work with girls, but in the lab, boys do the experiments much better and professionally higher than girls.

What do you think is your weakness in your teaching?

English I think my proficiency level in terms of the pronunciation of the biology concepts is not good. Sometimes, I need help from some other people for better pronunciation of the terms.

How many classes are you teaching?

This year, I am teaching three classes, each class has three lessons a week. This means that I have nine lessons a week because many students have left the school some afraid of the high teaching standard and others just following the movement. They have preferred to go to schools where the teaching standards are less challenging. This is why my teaching hours are not too high.

How do you maintain discipline in your class?

Very often, I divide my classes into groups. Each group contains weak, intelligent, shy, and aggressive students in order to reach some of their preachings.

What do you think are the reason for teaching biology?

It is very important to learn biology because it concerns all life phenomena around us. We need to teach biology to young people to give them insights that can help them develop their knowledge of the environment surrounding them and also develop their perception of living organisms.

What is your aim in teaching biology?

My aim is to help students reach the knowledge of the vital processes that occur in the environment around them and its effect on their bodies.

According to you what makes teaching biology relatively difficult?

When I consider the biology curriculum in middle and high school, I may say that; the teaching competencies of teachers make the teaching of biology difficult for students. For example, the basic concepts of osmosis and diffusion are taught in the preparatory stage, but when students have not well assimilated these basic concepts it becomes difficult at this level to deepen these notions as I have to build new knowledge on previously learned concepts. Sometimes, I need to give a full lesson on those notions to raise students at the required level for the lesson scheduled at the secondary school stage. For this reason, sometimes, I require students to do quick activities in groups.

How do you decide on which concepts to give priority and teach when it is almost the end of the semester?

When I do not have enough time, I consider and teach only the basic concepts of the unit or the main idea of the subject matter and expand it according to the availability of the time. For example, for Osmosis and Diffusion, the basic idea is the movement of the water molecules and substances through the semipermeable membrane and I have to make sure that my students have understood it.

When do you decide to move from one concept to another within the unit?

Before introducing a new lesson, I briefly present a summary of the previous lesson. Through this review and discussion, I note how well students have comprehended the concept. If I receive satisfactory answers from most students, then, I decide to go to the next concept.

How do you describe your students' participation in-class activities?

Before they start working on the experiment, they were confused and had problems with the normal procedure to follow. Consequently, they were not sure about their own final result and they did not get the right one, although I allow those who have the doubt to run the experiment at another time, they are afraid that the result will not appear in the exam.

Have you ever taught Osmosis and Diffusion before?

Yes, I have taught it several times, and I have checked what I have been teaching in this workshop we have attended. I am satisfied with my concept of knowledge of the subject within the limits of the school curriculum. Always I have been telling my students to comprehend what osmosis and diffusion are rather than memorize them and that they can reach the result by understanding the phenomenon and interpreting it.

What is the main objective of the osmosis and diffusion unit?

The main goal is to help students know the behavior of the cell. For example, to know how single-cellular and multicellular cells live in saltwater and freshwater, such as food, saline, or sugary, and to know how they are preserved and what happens to them. The position of algae and fungi does not grow or does spoil the food.

The concept such as “water stress” makes students’ comprehension difficult. What are other concepts also making it difficult for students to comprehend easily the lessons?

The water effort is not a problem for me although I have met some teachers who have a misunderstanding of the concept. For example, I know that Water effort is the number of water molecules in the solution. Therefore, when there is a 15% solution and a 10 % solution it means that water effort in the solution 10% is higher than the water effort in the solution 15% because of the high number of water molecules.

How do you correct students’ misconceptions of a given concept?

Through discussions and question-answer techniques, they identify their mistakes and correct them.

What are the factors you take into consideration when you are planning to teach a unit?

Very often, I consider the time and look at the number of components to exploit from the content. Sometimes I need more lessons for one unit, in the past, we used to prioritise our colleagues who needed more time to finish their lessons, but this year we all need time. In the allocation of hours for each course, the ministry of education has allocated 3 hours per week to biology in grade 10 at secondary school. With only 3 hours per week, it becomes impossible to teach extensively the curriculum. In this way, some activities mentioned in the curriculum are simply merged with others or compressed in a very short time. (The curriculum consists of three books, the class book, the book of activity, and the booklet of practical exercises.) For example, I use exercises as a test because of this time constraint.

How do you evaluate your students?

I evaluate my students either individually or collectively in small groups. Evaluation tasks are either theoretical or practical or they combine both aspects. Students design their reports on their own or through my guidance and according to time availability, they practice. so that the students take advantage of their time in the experiments rather than the time spent on design.

Did you know the 5Es learning strategy of the Biology course before?

No, I did not know it before. When students were experiencing carrots I did not do anything because I wanted them to discover what will happen. They prepare the carrots and salted water and tried the experimentation. First, they weight the carrots and they also used the thread before the experiment, and then they left in the slot and freshwater, and the second day I made the experience examined by the rest of the students to describe what happened with carrots. One of the carrots had increase in size and the other had decreased. Students were very excited about the experience.

Which evidence indicates that students actually learn?

Their enthusiasm and interest in practical work are the evidence. For example, in the case of osmosis and diffusion when students are able to justify the changes in sizes of carrots and when they want to check with the microscope what happened to the cells.

Why were you helping and guiding your students to reach the expected results?

This year, students do not have the required level. Therefore, considering the time constraint they need an assistant to reach the results in time. I did not give them the results directly but we discussed the process to use and this leads them in the right direction towards the expected results. Otherwise, they would not get it.

After having followed the workshop, do you feel that you have acquired something new which has changed your teaching practice?

Yes, there is a big change in my teaching practice especially at the teaching activities level, and at the assessment of the understanding of students. Thanks to the experiments we have done, I have learned and discovered things I did not know before, such as potatoes, carrots and egg, ... and when doing the tests I was not allowing students to answer each other questions, but with this workshop, I have understood that each student's answer is a piece of evidence that will help me to determine the level of students understanding. In addition, I have benefited from the discussions and dialogues sessions with other teachers present at the workshop. From the sessions, I have determined the advantages and disadvantages of the activities that I was conducting. The workshop was really important for me because it has helped me to evaluate myself in regard of methodological requirements and try to change the method of teaching as much as I can by adopting many of the new ideas I did not know before.

Have you changed your way of interacting with students after the workshop?

My interaction with students is quite rigorous. Some of the students are even afraid to attend my class, but, after having attended it they find that it is different and interesting. I do not like losing time because the time allocated to each lesson is not enough for all activities. Therefore, I've preferred to assess the students rather than losing lesson time. Osmosis and diffusion were supposed to be taught in the previous week, but due to the midterm examinations which were drawing near and the short time we had for preparation, I placed the samples before the lesson so that the students did not have to wait for the results, I had been helped by the lab assistant to practice the osmosis and diffusion's activities that we had done in the course of the sessions.

Is there any change in students' performance after you participate in the workshop?

Yes, there is a change. Students reacted positively when they saw the change in the experiment. They were also excited and much involved in the experiments, they were asking questions to understand what has happened and why this happened like that. I think this will stimulate them to study biology for scientific purposes.

How do you describe your students?

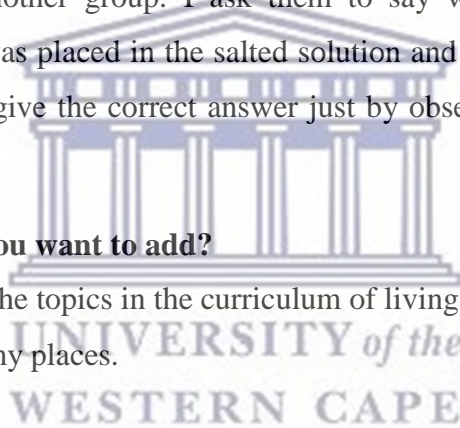
My class is a normal class where there are motivated students with the desire to learn and share knowledge with others and shy and non-motivated ones who do not want to learn at all. I am trying to help this category of students by involving them in group work with other students to motivate and push them to learn from them and work with them as a team. Another is the category of perfectionist students always fearing to make mistakes but I motivate them not to be scared of making mistakes because we sometimes learn from our mistakes in this case even if they give wrong answers I encourage them and help them to get the right one. Teaching grade 10 at secondary school is difficult because students are freshly coming from middle school and also they are teenagers.

What proves that students have learned what they were supposed to learn?

For example, in the case of osmosis and diffusion lesson, I use a sample of one group experiment to evaluate another group. I ask them to say which sample was placed in freshwater and which one was placed in the salted solution and they have to give the correct answer. If they are able to give the correct answer just by observation this proves that they have assimilated.

Are there any comments you want to add?

I wanted to reduce some of the topics in the curriculum of living organisms because the students studied them in many places.



Appendix 4 Observation schedule adopted and modified from (Kitta, 2004)

Observation	Notec		
	NO	ONPW	OPW
Introduction to the lesson			
Basic teaching skills			
1. Preparedness of the teacher for the lesson			
2. Teacher recall on the previous lessons and waits students' answer			
3. Teacher makes clear statement on the purpose of the lesson			
4. Teacher makes references to textbooks (where necessary)			
5. Teacher discusses and review previous homework (when necessary)			
Activity-based teaching			
1. Teacher introduces the lesson by an activity			
2. Teacher asks learners about their ideas about the activity			
3. Teacher clarifies how the activity will be conducted			
4. Teacher explains the relationship of the activity with the previous lesson			
5. Teacher establishes relevance of the activity to the learners' daily lives			
Subject matter knowledge			
1. Teacher gives appropriate information about the lesson			
2. Teachers gives accurate information to learners about the activity			
3. Teacher relates the information to the previous topics/lessons			
Body of the lesson			
Basic teaching skills			
1. Teacher has all the necessary teaching materials			
2. Teacher ensures all the students participate			
3. Teacher encourages students to ask questions			
4. Teacher organises students in groups			
5. Teacher supervises group presentations			
6. Teacher effectively handles timing difficulties			
7. Teacher moves round the class			
8. Teacher's preparedness contributes to a smooth lesson			
9. Teacher maintains positive learning environment during activity			
Activity-based teaching			
1. Teacher introduces the activity			
2. Teacher gives the objective of the activity			
3. Teacher divides class in groups for the activity			
4. Teacher demonstrates how to do the activity			
5. The demonstration is visibly clear to all the learners			
6. Teacher supports groups of students by asking questions			
7. Teacher supports groups of students by giving advice			
8. Teacher gives clear instructions on how to perform the activity			
9. Teacher closely supervises the groups by moving around the class			
10. Teacher interacts equally with all groups			
11. Teacher encourages learners to ask questions			
12. Teacher allows sufficient time to answer questions			
13. Teacher interacts with students during activities			
Subject matter knowledge			

1. Teacher relates appropriately one activity to another			
2. Teacher answers students' questions correctly			
3. Teacher clarifies the new terms and concepts appropriately			
Conclusion of the lesson			
Basic teaching skills			
1. Teacher summarises the lesson			
2. Teacher asks groups to present their results			
3. Teacher summarises the findings of activity			
4. Teacher spends time to discuss the activity thereafter			
5. Teacher asks learners questions and waits for responses			
6. Teacher encourages learners to ask questions			
7. Teacher gives homework			
8. Teacher explains the significance of the homework			
9. Teacher clarifies how the homework will be done			
Activity-based teaching			
1. Teacher asks the group to report their results to the class			
2. Teacher draws conclusion from the activity(ies)			
3. Teacher, together with learners, draw conclusions from the activities			
4. Teacher guides the learners to know the differences in their results			
Subject matter knowledge			
1. Teacher correctly clarifies the results of the activity			
2. Teacher relates the activity with the theory behind it			
3. Teacher provides theoretical conclusion from activity			
4. Teacher appropriately summarises the lesson			
General impression			
Basic teaching skills			
1. Teacher asks thought inciting questions			
2. Teacher listens to students' answers			
3. Teacher encourages students to ask questions			
4. Teacher is well prepared for the lesson			
5. Teacher uses the time rationally			
6. Teacher uses classroom aids properly			
7. Teacher improvises the teaching aids			
8. Teachers uses teaching aids to make the lesson more clear			
Activity-based teaching			
1. Teacher organises students in groups for classroom activities			
2. Teacher clarifies the activities			
3. Teacher guides students in doing activities			
4. Teacher gives students opportunity to reflect on the results			
Subject matter knowledge			
1. Learners meet overall lesson objectives			
2. Teacher appears confident in lesson content			
3. Teacher seem to have firmed the understanding of the subject area			

❖ NO=Not Observed, ONPW= Observed but not performed well, OPW=Observed and performed well

Appendix 5 the Osmosis and Diffusion Diagnostic Test (ODDT)

ADOPTED AND MODIFIED FROM (Odom, 1995)

1a - Suppose there is a large beaker full of clear water and a drop of blue dye is added to the beaker of water. Eventually, the water will turn a light blue color. The process responsible for blue dye becoming evenly distributed throughout the water is:

- a. Osmosis
- b. Diffusion
- c. A reaction between water and dye

1b. The reason for my answer is:

- a. The lack of a membrane means that osmosis and diffusion cannot occur.
- b. There is a movement of particles between regions of different concentrations.
- c. The dye separates into small particles and mixes with water.
- d. The water moves from one region to another.

2a- During the process of diffusion, particles will generally move from:

- a. High to low concentrations
- b. Low to high concentrations

2b. The reason for my answer is:

- a. There are too many particles crowded into one area, therefore they move to an area with more space.

b. Particles in areas of greater concentration are more likely to bounce toward other areas.

c. The particles tend to move until the two areas are isotonic and then the particles stop moving.

d. There is a greater chance of the particles repelling each other.

3a. as the difference in concentration between two areas increases, the rate of diffusion:

- a. Decreases
- b. Increases

3b. The reason for my answer is:

- a. There is less room for the particles to move.
- b. If the concentration is high enough, the particles will spread less and the rate will be slowed.

c. The molecules want to spread out.

d. The greater likelihood of random motion into other regions.

4a. A glucose solution can be made more concentrated by:

- a. Adding more water
- b. Adding more glucose

4b. The reason for my answer is:

- a. The more water there is the more glucose it will take to saturate the solution.

- b. Concentration means the dissolving of something.
 - c. It increases the number of dissolved particles.
 - d. For a solution to be more concentrated, one must add more liquid.
- 5a. If a small amount of sugar is added to a container of water and allowed to sit for a very long period of time without stirring, the sugar molecules will:

- a. Be more concentrated on the bottom of the container.
- b. Be evenly distributed throughout the container

- 5b. The reason for my answer is:
- a. There is a movement of particles from a high to low concentration.
 - b. The sugar is heavier than water and will sink.
 - c. Sugar dissolves poorly or not at all in water.
 - d. There will be more time for settling.

- 6a. Suppose you add a drop of blue dye to a container of clear water and after several hours the entire container turns light blue. At this time, the molecules of dye:
- a. Have stopped moving
 - b. Continue to move around randomly

6b. The reason for my answer is:

- a. The entire container is the same colour; if the dye molecules were still moving, the container would be different shades of blue.
- b. If the dye molecules stopped, they would settle to the bottom of the container.
- c. Molecules are always moving.
- d. This is a liquid; if it were solid the molecules would stop moving.

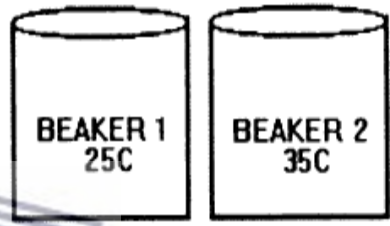


Figure 1

7a. Suppose there are two large beakers with equal amounts of clear water at two different temperatures. Next, a drop of green dye is added to each beaker of water. Eventually, the water turns light green (see Figure 1). Which beaker became light green first?

- a. Beaker 1
- b. Beaker 2

- 7b. The reason for my answer is:
- a. The lower temperature breaks down the dye.
 - b. The dye molecules move faster at higher temperatures.
 - c. The cold temperature speeds up the molecules.
 - d. It helps the molecules to expand.

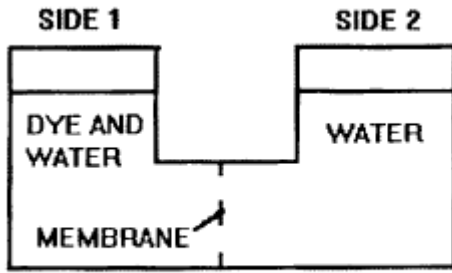


Figure 2

8a- In Figure 2, two columns of water are separated by a membrane through which only water can pass. Side 1 contains dye and water; Side 2 contains pure water. After two hours, the water level in Side 1 will be:

- a. Higher
- b. Lower
- c. The same height

8b. The reason for my answer is:

- a. Water will move from the hypertonic to the hypotonic solution.
- b. The concentration of water molecules is less on Side 1.
- c. Water will become isotonic.
- d. Water moves from low to a high concentration.

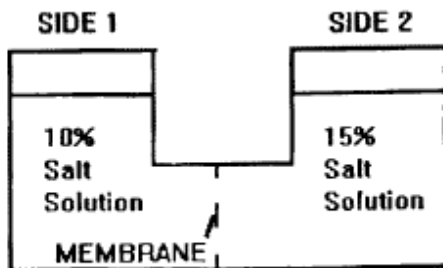


Figure 3

9a- In Figure 3, Side 1 is _____ to Side 2.

- a. Hypotonic
- b. Hypertonic
- c. Isotonic

9b. The reason for my answer is:

- a. Water is hypertonic to most things.
- b. Isotonic means "the same".
- c. Water moves from a high to a low.
- d. There are fewer dissolved articles on Side1.

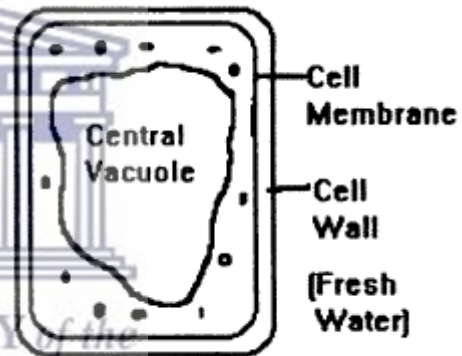


Figure 4

10a. Figure 4 is a picture of a plant cell that lives in freshwater. If this cell was placed in a beaker of 25% saltwater solution, the central vacuole would:

- a. Increase in size
- b. Decrease in size
- c. Remain the same size.

10b. The reason for my answer is:

- a. Salt absorbs the water from the central vacuole.

b. Water will move from the vacuole to the saltwater solution.

c. The salt will enter the vacuole.

d. Salt solution outside the cell cannot effect the vacuole inside the cell.

11a. Suppose you killed the plant cell in Figure 4 with poison and placed the dead cell in a 25% saltwater solution. Osmosis and diffusion would:

a. Not occur

b. Continue

c. The only diffusion would continue

d. Only osmosis would continue

11b. The reason for my answer is:

a. The cell would stop functioning.

b. The cell does not have to be alive.

c. Osmosis is not random, while diffusion is a random process.

d. Osmosis and diffusion require cell energy.

12a. All cell membranes are:

a. Semipermeable

b. Permeable

12b. The reason for my answer is:

a. They allow some substances to pass.

b. They allow some substances to enter, but they prevent any substance from leaving.

c. The membrane requires nutrients to live.

d. They allow ALL nutrients to pass.



Appendix 6 Crosstab for each Question in the ODD Test

Question-1- Suppose there is a large beaker full of clear water and a drop of blue dye is added to the beaker of water. Eventually, the water will turn a light blue color. The process responsible for blue dye becoming evenly distributed throughout the water is:

reason	Answer		Osmosis	Diffusion	A reaction between water and dye
	Pre	Post			
The lack of a membrane means that osmosis and diffusion cannot occur.	Pre	0	0	1	0
	Post	0	0	0	0
There is a movement of particles between regions of different concentrations.	Pre	0	0	19*	0
	Post	0	0	20*	0
The dye separates into small particles and mixes with water.	Pre	0	0	1	1
	Post	0	0	2	0
The water moves from one region to another.	Pre	0	0	0	0
	post	0	0	0	0

* The correct answer

Question-2- During the process of diffusion, particles will generally move from:

reason	Answer		High to low concentrations	Low to high concentrations
	Pre	Post		
There are too many particles crowded into one area, therefore they move to an area with more space.	Pre	4*	0	0
	Post	13*	0	0
Particles in areas of greater concentration are more likely to bounce toward other areas.	Pre	1	0	0
	Post	4	0	0
The particles tend to move until the two areas are isotonic and then the particles stop moving	Pre	17	0	0
	Post	4	0	0
There is a greater chance of the particles repelling each other.	Pre	0	0	0
	post	1	0	0

* The correct answer

Question_3_ As the difference in concentration between two areas increases, the rate of diffusion:

reason	Answer		Decreases	Increases
	Pre	Post		
There is less room for the particles to move.	Pre	1	2	2
	Post	0	0	0
If the concentration is high enough, the particles will spread less and the rate will be slowed.	Pre	0	2	2
	Post	0	0	0
The molecules want to spread out.	Pre	0	5	5
	Post	0	4	4
The greater likelihood of random motion into other regions.	Pre	0	12*	12*
	post	0	18*	18*

* The correct answer

Question_4_ A glucose solution can be made more concentrated by:

reason	Answer		Adding more water	Adding more glucose
	Pre	Post		
The more water there is, the more glucose it will take to saturate the solution.	Pre	0	0	0
	Post	0	0	0
Concentration means the dissolving of something.	Pre	0	0	2
	Post	0	0	1
It increases the number of dissolved particles.	Pre	0	0	20*
	Post	0	0	21*
For a solution to be more concentrated, one must add more liquid.	Pre	0	0	0
	post	0	0	0

* The correct answer

Question_5_ If a small amount of sugar is added to a container of water and allowed to sit for a very long period of time without stirring, the sugar molecules will:

reason	Answer		Be more concentrated on the bottom of the container	Be evenly distributed throughout the container
	Pre	Post		
There is a movement of particles from a high to low concentration.	Pre	4	4	9*
	Post	4	4	12*
The sugar is heavier than water and will sink.	Pre	4	4	1
	Post	1	1	0
Sugar dissolves poorly or not at all in water.	Pre	2	2	0
	Post	0	0	0
There will be more time for settling.	Pre	2	2	0
	post	3	3	2

* The correct answer

Question-6- Suppose you add a drop of blue dye to a container of clear water and after several hours the entire container turns light blue. At this time, the molecules of dye:

reason	Answer		Have stopped moving	Continue to move around randomly
	Pre	Post		
The entire container is the same colour; if the dye molecules were still moving, the container would be different shades of blue.	Pre	1	1	1
	Post	1	1	1
If the dye molecules stopped, they would settle to the bottom of the container.	Pre	4	4	2
	Post	0	0	0
Molecules are always moving.	Pre	1	1	13*
	Post	0	0	20*
This is a liquid; if it were solid the molecules would stop moving.	Pre	0	0	0
	post	0	0	0

* The correct answer

Question-7- Suppose there are two large beakers with equal amounts of clear water at two different temperatures. Next, a drop of green dye is added to each beaker of water. Eventually, the water turns light green. Which beaker became light green first?

reason	Answer	Beaker 1	Beaker 2
The lower temperature Breaks down the dye.	Pre	0	0
	Post	0	0
The dye molecules move faster at higher temperatures.	Pre	0	21*
	Post	0	22*
The cold temperature speeds up the molecules.	Pre	0	1
	Post	0	0
It helps the molecules to expand.	Pre	0	0
	post	0	0

* The correct answer

Question-8- In Figure 2, two columns of water are separated by a membrane through which only water can pass. Side 1 contains dye and water; Side 2 contains pure water. After two hours, the water level in Side 1 will be:

reason	Answer	Higher	Lower	The same height
Water will move from the hypertonic to the hypotonic solution.	Pre	10*	1	1
	Post	14*	0	0
The concentration of water molecules is less on Side 1.	Pre	4	5	0
	Post	3	0	0
Water will become isotonic.	Pre	0	0	0
	Post	0	0	0
Water moves from low to a high concentration.	Pre	1	0	0
	post	1	4	0

* The correct answer

Question-9- In Figure 3, Side 1 is _____ to Side 2.

reason	Answer	Hypotonic	Hypertonic	Isotonic
Water is hypertonic to most things.	Pre	1	0	0
	Post	0	0	0
Isotonic means "the same".	Pre	0	0	0
	Post	0	0	0
Water moves from a high to a low.	Pre	3	2	0
	Post	1	7	0
There are fewer dissolved articles on Side1.	Pre	8	8*	0
	post	3	14*	0

* The correct answer

Question-10- Figure 4 is a picture of a plant cell that lives in freshwater. If this cell was placed in a beaker of 25% saltwater solution, the central vacuole would:

reason	Answer	Increase in size	Decrease in size	Remain the same size
Salt absorbs the water from the central vacuole.	Pre	0	1	0
	Post	0	0	0
Water will move from the vacuole to the saltwater solution.	Pre	0	20*	0
	Post	0	22*	0
The salt will enter the vacuole.	Pre	1	0	0
	Post	0	0	0
Salt solution outside the cell cannot effect the vacuole inside the cell.	Pre	0	0	0
	post	0	0	0

* The correct answer

Question-11- Suppose you killed the plant cell in Figure 4 with poison and placed the dead cell in a 25% saltwater solution. Osmosis and diffusion would:

reason	Answer	Not occur	Continue	Only diffusion	Only osmosis
The cell would stop functioning.	Pre	10*	0	0	0
	Post	16*	0	0	0
The cell does not have to be alive.	Pre	0	1	2	2
	Post	0	1	1	0
Osmosis is not random, while diffusion is a random process.	Pre	1	1	2	0
	Post	1	0	2	1
Osmosis and diffusion require cell energy.	Pre	3	0	0	0
	post	0	0	0	0

* The correct answer

Question-12- All cell membranes are:

reason	Answer	Semipermeable	Permeable
They allow some substances to pass.	Pre	5	0
	Post	2	0
They allow some substances to enter, but they prevent any substance from leaving.	Pre	16*	0
	Post	20*	0
The membrane requires nutrients to live.	Pre	0	0
	Post	0	0
They allow all nutrients to pass.	Pre	0	1
	post	0	0

* The correct answer