DNA Fingerprints – Olive Cultivation Problem

Hallo….

My Name is Talal Hdeib, I work as supervisor in the Ministry of Education – Jordan.

I will talk to you today about a problem a farmer faced. This farmer decided to cultivate his field with olive trees. Before talking about the farmer's problem, I like to share with you some information about olive trees. Olive trees are considered blessed trees; they belong to the *Oleaceae family*. It is a perennial plant, Olive cell has 46 chromosome (2n =46). It is historically known for its oil and fruits. Cultivation of olives was traditionally important in the Mediterranean region as people depend on it for food and oil. Its oil was also used for lighting up old lamps.

Olive oil was commercially important for the Mediterranean region and is still considered one of the traditional diets in the region.

One of the most important problems in olive cultivation is the wide **diversity** of cultivars; some cultivars produce huge amounts of oil while others have very limited production. Because of this variation, many synonyms and homonyms of cultivars names is a long standing problem in olive producing countries worldwide. This caused a real problem in cultivating and farming the desired cultivars. To guarantee high quality products of international standard are produced it is necessary to identify cultivars.

When we cultivate olives for the first time, the tree needs about 4-5 years to grow and give fruits, once it gives fruits we can observe the fruits and identify the sort of cultivar form others.

In our farmers's case, he bought olive seedlings from a variety that he knows as "*Nabali*" which is known in production of large amounts of oil. He doubted that the nursery workers may have sold him the wrong variety. Since confirmation of olive variety based on phenotype features is impossible except after the trees grow up and give fruits. In other words taking care of trees for 4-5 years before you know that it is the desired quality. So he started thinking of any possible way to test the variety quickly and without wasting the time and the effort of 5 years before the tree grows up and gives fruits, then discover it is the wrong type.

How can the farmer identify olive cultivars without wasting his expenses and money and time before he is sure of the desired quality? Do you have any idea to help him solve this problem?

I will leave you for few minutes to think together and come up with ideas to help the farmer identify the variety without waiting.

Segment two

I hope you were able to come up with some ideas to solve the farmer's problem. If you could not reach to a solution I will give you a hint that will help in finding the correct solution.

I will show you this figure; it shows the structure of a DNA molecule. I want you to discuss the following points with your teacher.

1- How many strands make up the DNA molecule?
2- How many kinds of nitrogenous bases are there in the DNA molecule?
3- How does DNA molecules differ form one organism to another?

I will give you the chance to discuss this; you may reach hint that will help the famer in solving olive cultivation problem. See you in few minutes.

Segment Three:

I hope the information you reached by discussion about DNA structure.

We will share the information together.

The characteristics of all living organisms, including humans, are essentially determined by information contained within DNA that they inherit from their parents. DNA structure can be imagined as a zipper with each tooth representing one of four letters A, C, G, or T (nitrogenous bases)

In the figure you can see that the DNA molecule is two strands making a double helix shape, one strand is colored with red color while the other is blue. Once double strands are unwound we can see the nitrogen basses that form them.

Similarly to what happens when unzipping a zipper. We can notice that at each tooth there one symbol which represents one of the nitrogen bases composing the DNA molecule. The letters A, C, G, and T stand for adenine, cytosine, guanine, and thymine, the basic building blocks of DNA. For example the nitrogen base adenine links with thymine, and guanine links with cytosine all along the DNA double helix.

The chemical composition of the DNA molecule is the same for all living organisms; it has the same structure, and the same 4 nitrogen bases with the same links where adenine links with thymine, and guanine links with cytosine all along the DNA double helix.

Then how does DNA molecule differs form one organism to another?

Living organisms that look different or have different characteristics also have different DNA sequences. The more varied the organisms, the more varied the DNA sequences.
For example the sequence ATTCG codes for some genetic information that differs from the information given by GCTTA though we are using the same nitrogen bases and same symbols. This is similar to the difference between word the MEAN and the word NAME. The two words are from the same four letters, but each has a different meaning because of the different sequence of the letters. Similarly, genetic information on the DNA varies.
What we are concerned today is; how to find a quick method through which we can distinguish one molecule of DNA from another, a DNA sequence from another DNA sequence for different organisms?
The greater the differences among living organisms, the greater the difference in the DNA sequence among them. While the closer the DNA sequence along the DNA strands among living organisms the more alike they would be.
Now, I want you to think of a quick and simple method through which we distinguish different strand DNA from one another. Or how can we compare the differences of DNA molecules among individuals?
May be this method help the farmer in identifying the desired quality of olives … I will see you in few minutes.

Segment Four

I hope you have reached to a quick and suitable method through which we can compare and identify DNA strands coming form different organisms
Biotechnology is one of new Biological sciences; it supplied scientists with a group of lab techniques through which we can compare among different DNA strands taken from different living organisms
The first method used in for this purpose is DNA fingerprints, or RFLP method.
DNA fingerprinting is a very quick way to compare the DNA sequences of any two or more living organisms.
We can summarize this method with the following steps:
In this figure we can see the steps used to find the DNA fingerprints or RFLP which is one method used for this purpose.
According to the drawing shown this method is composed of six steps that need to be done serially in the lab.
DNA must be recovered from the cells or tissues of the body. Only a small amount of tissue - like blood, hair, or skin - is needed. For example, the amount of DNA found at the root of one hair is usually sufficient.

After isolating the DNA strand from the tissues, some special enzyme are added, called restriction enzymes which is used to cut the DNA at specific locations.

The most important part in this technique is the enzyme, how does it work? This figure illustrates how this restriction enzyme works .This enzyme is called (EcoR1) which is an enzyme that we extract form one kind of bacteria. This enzyme is specific, i.e. the enzyme locates a specific sequence of the DNA strand and works on it. It cuts the DNA strand where ever the sequence GAATTC occurs.
For example the enzyme locates the GAATC sequence and breaks the bond between A and G as seen in the figure. The upper strand has the sequence GAATTC, the enzyme braked the bond between A and G.
The lower strand is the complementary of the upper strand and has the sequence GAATTC, the breaking down of the bond happened at A and G again. So the two strands are cut at specified locations.
The more this sequence is repeated in a DNA strand the more segments will be produced. On the other hand, if it is repeated few times only then the resulted segments will be less. Depending on this fact we can find the difference among living organisms. The number of segment resulted by using this enzyme, tells how often this sequence occurs in one organism's DNA compared to the other.

After adding the enzyme we go back to the third step which is called gel electrophoresis. This technique is used to sort resulted DNA segments according to their length by a sieving technique called electrophoresis.
This technique depends on exposing the DNA fragments to an electric current. It is well known the DNA is negatively charged which will cause the DNA segments to travel towards the positive pole through the gel. The short segments of the DNA will move faster than the longer segments. By exposing the gel to X-ray we can figure the strands with the naked eyes.
Then we go to step four,
In this step the DNA segments are transferred from the gel into a nylon sheet to make it easier to deal with, and to make it easier to take some photographic pictures.
The distribution of DNA pieces is transferred to a nylon sheet by placing the sheet on the gel and soaking them overnight Sponge peaces are placed on top of the nylon tissue to suck the water upwards dragging with it the DNA segments form the gel into the nylon tissue.

Then we need to add some small pieces of DNA called probes, these are manufactured DNA chains made in the nucleotides lab, they bear radioactive materials which facilitates image taking.
Adding radioactive or colored probes to the nylon sheet produces a pattern called the DNA fingerprint. Each probe typically sticks in only one or two specific places on the nylon sheet.

For example, if a DNA segment contains a sequence such as TACG, it needs to look for a complementary segment that has the sequence ATGC to link with. After that we can take images of the nylon tissue using X-ray. The DNA fingerprints appear in shape of bands arranged on top of each other.
If the numbers 1,2,3,4 represent DNA fingerprints taken form different organisms then we can see that the DNA strand 1 linked with big number of radioactive chains on the nylon , while the DNA no, 2 linked with fewer radioactive probes .The strand 3 is linked to at different locations and so on.
This is how we can distinguish samples by the number of bars seen on the figure. If each sample was taken from different organisms we can see that number of strands differs from one organism to another, i.e. each has his own DNA fingerprints. This is similar to the barcode used in supermarkets to identify different articles. Once the items barcode is scanned by the barcode detector, its kind and price are identified.

The technique we talked is one among other to figure the DNA fingerprints. Do you think this would help the farmer to choose the desired quality of olives? How can that be done?
Now you know how to figure out the DNA fingerprint. Can you help the farmer to identify olive cultivars?
Are there other methods used to figure out the fingerprints in addition to RFLP? Look for an answer and I will come back to you

Segment five

Now, and after helping the farmer to solve his problem of olive cultivars using the DNA fingerprint, I will ask you to thinks of solving other complicated problems that are more critical than the famer's problem.
Is it possible to use DNA fingerprints in diagnosis of inherited diseases in adults, children, infants, and embryos?
Is it possible to use DNA fingerprints in identifying criminals and catastrophe victims?
I will give some time to think about that.
And one of the important problems in our life is to detect bacteria and other organisms that may pollute air, water, soil, and food? How?
DNA fingerprints can also help us in determination of pedigrees of seeds and livestock.

One other field where DNA fingerprints are so important is matching organs from donors with the most suitable receiver before the transplantation occurs.
It can be used also be used in proving and confirming paternity or maternity of a child. How?
What I want to ask you to discuss these applications to solve problems that we may face in our daily life.

Segment six

Teacher's guide

Welcome dear teachers. I am Talal Hdeib , I work as supervisor in ministry of education – Jordan .

I will share with you some options that you may apply during the breaks. However, you can still have your own activates if you want.

In the first break,

After sharing the problem with the students, please try to divide the students into groups and ask them to think of a solution. After the groups are done, write all their solutions on the board without the mentioning the correct solution.

In the second break;

After mentioning a hint about the DNA fingerprints, supply each group of students with a drawing of DNA structure, or show a big drawing of DNA structure, or DNA model- what ever is available, then allocate a question of the mentioned questions in the segment for each group, this would give more time and decrease the effort.

In the third break,

Ask each group of students to browse the internet to answer the questions, if this is not available you can provide the student with some books to look for the information. Note: *You should be sure that the needed answers are included in you're the chosen books'*.

In the fourth break,

After dealing with the farmer's problem; we still have some more problems to share with the students. The six problems mentioned in the fifth segment are shared briefly. Then ask each group to discuss one of the problems among themselves and communicate their results with the rest of the class.

By this we covered all the suggested ideas that can be used during the breaks. However, dear teachers you can use your own activates, according to your needs, students' number, facilities availability.
I hope that this module is useful, and you can use in your classes.
Thanks you and see you.