Teacher Guide

BLOSSOMS: Tissue Specific Gene Expression

Rabih Talhouk,
Dept of Biology
American University of Beirut
Beirut, Lebanon

July 2012

Concept:

Tissue Specific Gene Expression: How is it that all cells in our body have the same genes, yet cells in different tissues express different genes?

A basic notion in biology that most high school students fail to conceptualize is the fact that all cells in the animal or human body contain the same DNA yet different cells in different tissues express, on the one hand, a set of common genes, and on the other, express another set of genes that vary depending on the type of tissue and the stage of development. The first set of genes are referred to as "house-keeping genes" and are needed, as the term implies, to sustain basic functions of a cell such as nutrient uptake, protein synthesis, DNA synthesis and other basic metabolic functions. The latter set of genes, are responsible for the synthesis of proteins specifically produced by one cell/tissue type but not by another, and at a certain stage of development. **How do cells, at the level of the nucleus, which houses the complex chromatin, regulate this mode of tissue specific gene expression?**

In this video lesson the student will be reminded that genes in a cell/tissue are expressed when certain conditions in the nucleus are met. The presence of RNA polymerase; and the availability of the right set of transcription factors that work together with RNA polymerase to start gene transcription. **More importantly the students will appreciate that a third crucial condition needs to be met;** namely the ability of the RNA polymerase and the transcription factors to access the gene of concern, to be able to transcribe it. This latter is not a simple deed. Proper topological positioning of the gene in the nucleus is needed to render it accessible to the polymerase and the transcription factors.

Interestingly, the system utilized by the cell to ensure tissue specific gene expression is rather simple. Among other factors**, the cells make use of a tiny scaffold known as the "Nuclear Matrix or Nucleo-Skeleton".** The 2 meters worth of DNA are wrapped into nucleosomes (histone containing structures) and folded into chromatin onto this tiny scaffold inside the nucleus so that the genes that are expressed are those that are in an unfolded area of the genome and projecting outward in a manner accessible to the RNA polymerase and transcription factors. Those that are not expressed in a particular cell are tucked away deep inside the scaffold and are not accessible to the transcription machinery.

The activity will take the students through an interactive thought process to allow them to conclude this complex set up of the chromatin in the nucleus and its interaction with the Nuclear Matrix.

The video lesson spans 20 minutes and provides 5 exercises for students to work out in groups and in consultation with their classroom teacher. The entire duration of the video demonstration and exercises should take about 45-50 minutes, or equivalent to one classroom session.

An 8 minute Teacher's Guide is inserted at the end of the 20 minute interactive video lesson. In the guide there are suggestions on how the teacher can solicit the students' participation in the exercises.

There are no supplies needed for students' participation in the provided exercises. They will only need their notebooks and pens. However, the teacher may wish to emulate the demonstrations used in the video lesson by the presenter and in this case simple material can be used as those used in the video. These include play dough, pencils, rubber bands (to construct the nuclear matrix model), a tennis ball and 2-3 Meters worth of shoe laces.

The students should be aware of basic information about DNA folding in the nucleus, DNA replication, gene transcription, translation and protein synthesis.