Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_\_\_\_

**Microarray Paper Simulation**

1. In this lab, we will study gene expression (making mRNA) in skin cancer cells as compared to those in normal, healthy skin cells. Complimentary DNA or cDNA is made from the mRNA of cancer cells and will be labeled red, and the cDNA made from the mRNA from normal cells will be labeled blue. If neither cell is expressing a gene which means it’s not making mRNA for that gene, then the spot shows black. What three colors are seen in most microarrays used in scientific research? What type of cells are you studying?

2. If the cDNAs made from the cancer cells’ mRNA are labeled red, and the cDNAs made from the normal cells’ mRNA are labeled blue, for each of the situations below, describe what color you expect the gene spot to be on a microarray; red, blue, or purple.

|  |  |
| --- | --- |
| **GENE DESCRIPTION** | **COLOR OF SPOT** |
| A gene was expressed (making mRNA) more in cancer cells than in normal cells. |  |
| A gene was expressed the same in both cells. |  |
| A gene wasn't expressed at all in either cell. |  |
| A gene was expressed (making mRNA) more in normal cells than in cancer cells. |  |

|  |  |
| --- | --- |
| **Gene** | **Definition** |
| **Gene 1. P53 Gene**also known as **TP53** or **tumor protein**  | This gene codes for a protein that controls the cell cycle and functions as a tumor suppressor. Therefore it keeps tumors or cancers from forming or growing too big. |
| **Gene 2. Brain-derived neurotrophic**also known as **BDNF** | This protein acts on certain nerve cells of the [central nervous system](http://en.wikipedia.org/wiki/Central_nervous_system), helping to support the survival of existing neurons, and encourage the growth and of new neurons or nerve cells. |
| **Gene 3. Cytochrome C** | Cytochrome c is primarily known as an electron-carrying mitochondrial protein. It is known as a catalyst of respiration, forming reactions between the respiration molecules and oxygen.  |
| **Gene 4. Adenomatous polyposis coli (APC)** | *APC* is classified as a [tumor suppressor gene](http://en.wikipedia.org/wiki/Tumor_suppressor_gene). Tumor suppressor genes prevent the uncontrolled growth of cells that may result in cancerous tumors.  |
| **Gene 5. Lactosylceramide alpha- 2, 3 -sialyltransferase- ST3GAL5** | Ganglioside GM3 helps create lipids used for cell to cell messaging for cell growth and division, transportation and survival. |
| **Gene 6. Ras- p21/Ras** | Ras is the name given to a [family of related proteins](http://en.wikipedia.org/wiki/Protein_family) found inside[cells](http://en.wikipedia.org/wiki/Cell_%28biology%29) and are involved in transmitting signals within cells. When Ras is 'switched on' by incoming signals, it then switches on other proteins, and those proteins turn on genes involved in [cell growth](http://en.wikipedia.org/wiki/Cell_growth), [differentiation](http://en.wikipedia.org/wiki/Differentiation_%28cellular%29) and [survival](http://en.wikipedia.org/wiki/Apoptosis). As a result, mutations in Ras genes can lead to the production of permanently activated Ras proteins, meaning they are always turned on. |

**Six genes are studied in this paper “microarray” activity:**

**Read about the 6 genes you will study in this microarray paper simulation. Match the correct function to each gene using the Microarray Gene Cards. Capture your simplified function below, then predict if each gene will be expressed in the cancerous and non-cancerous cell.**

|  |  |  |
| --- | --- | --- |
| **Gene** | **Simplified Function** | **Prediction: Do you think the two cells will express this gene?** |
| **Cancer** | **Non-Cancer** |
| **Gene 1. P53 Gene**also known as **TP53** or **tumor protein** |  |  |  |
| **Gene 2. Brain-derived neurotrophic**also known as **BDNF** |  |  |  |
| **Gene 3. Cytochrome C** |  |  |  |
| **Gene 4. Adenomatous polyposis coli (APC)** |  |  |  |
| **Gene 5. Lactosylceramide alpha- 2, 3 -sialyltransferase- ST3GAL5** |  |  |  |
| **Gene 6. Ras- p21/Ras** |  |  |  |

**Simulation Set-Up**

You have a microarray with six circles with a single-stranded DNA probe. A DNA probe is a DNA sequence that codes for one of the six genes listed above. Each of the six probes may have complimentary matches to the cDNA. If the two DNA strands are complimentary, hybridization occurs and the cDNA attaches to the DNA probe.

A cancer patient has both normal and cancerous cells removed. The mRNA is extracted from both cells and made into cDNA. The cDNA from the cancer cells are tagged with a RED fluorescent colored dye and the normal cells cDNA are tagged with a BLUE fluorescent colored dye.

**Procedure**

1. Cut out the red and blue cDNA pieces. This may be done by students or the teacher.
2. Divide your table of 4 students into groups of 2. One group of 2 students will receive the red, cancerous cDNA pieces. The other two students will receive the blue, non-cancerous cDNA pieces.
3. You will now pretend to wash the microarray with the tagged cDNA by complementary matching or hybridizing the cDNA to the DNA probes on the microarray slide.

**Note**: Complimentary matching can begin anywhere on the DNA probe! It does NOT necessarily have to be at the beginning of the DNA sequence.

1. The region or circle on the microarray will glow **red** if only cDNA from the cancer cells’ hybridizes.

The region or circle on the microarray will glow **blue** if only cDNA from the normal cells’ hybridizes. The region or circle on the microarray will glow **purple** (contain both red and blue paper cDNA strands) if cDNA from both the normal and cancer cells’ hybridizes. If cDNA from neither the cancerous or normal cells’ hybridizes, the region will **not glow** at all.

7. Record your results in the "**Microarray Results**” section below.

**Microarray Results:**

Number of DNA sequences attached:

Red =

Blue =

Color:

Number of DNA sequences attached:

Red =

Blue =

Color:

Number of DNA sequences attached:

Red =

Blue =

Color:

Number of DNA sequences attached:

Red =

Blue =

Color:

Number of DNA sequences attached:

Red =

Blue =

Color:

Number of DNA sequences attached:

Red =

Blue =

Color:

Number of DNA sequences attached:

Red =

Blue =

Color:

Number of DNA sequences attached:

Red =

Blue =

Color:

Gene 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Gene 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Gene 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Gene 4: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Gene 5: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Gene 6: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Analysis of Results**

**Analysis of Results:**

1. Which gene(s) were expressed (transcribed) in the skin cancer cells? How do you

 know?

2. Which gene(s) were not expressed in the skin cancer cells? How do you know?

3. Which gene was not expressed in either skin cell type?

4. Why do think that gene was not expressed? (Hint: Think about the type of cell you are using in the

 microarray)

5. Why do you think that genes 3 and 5 are expressed in both skin cell types, as well as all cells in the body?

6. Choose at least one gene you think may play a role in causing cancer in cells. Explain why you chose that gene and not other genes based upon the microarray results. **(on-level)**

Choose two or more genes you think may play a role in causing cancer in cells. Explain why you chose those genes and not other genes based upon the microarray results**. (honors)**

|  |  |
| --- | --- |
| **Gene 1:** **P53 Gene** | Helps produce lipids for cell division, movement and survival(It is the “brakes” for cell division) |
| **Gene 2:** **Brain-derived neurotrophic** | Starts cellular respiration  |
| **Gene 3:****Cytochrome C** | Helps neurons to survive and grow |
| **Gene 4:****Adenomatous polyposis coli (APC)** | Sends messages to turn on genes (It is the “accelerator” for cell division)  |
| **Gene 5: Lactosylceramide alpha- 2, 3 -sialyltransferase- ST3GAL5** | Prevents tumor growth  (It is the “brakes” for  cell division) |
| **Gene 6:****Ras- p21/Ras** | Prevents tumor growth (It is the “brakes” for cell division) |