Cancer and Cell Differentiation
Recall

- The cell cycle consists of interphase, mitosis, and cytokinesis.
Recall

- During S phase of interphase, the DNA is replicated to prepare for mitosis. Each daughter cell must have a nucleus containing genetic information that is identical to that that was in the parent cell.
Cell Cycle Checkpoints

- During this process of DNA replication, or at other times during the cell cycle, ‘mistakes’ can be made in the sequence of nucleotides in DNA (similar to a typo in a sentence or word).
Cell Cycle Checkpoints

- Depending on the severity of the error, this could cause large problems for the cell if it is not able to be repaired before it is passed on to subsequent cells.
Cell Cycle Checkpoints

- To prevent these errors from being passed on, cell cycle checkpoints involve proteins that make sure the DNA is replicated correctly to divide.
Tumour Formation

- If the errors in the DNA sequence affect the components that control the cell cycle, it could lead to uncontrolled cell division and growth of functionless cells.
Tumour Formation

- A benign tumour does not harm other surrounding tissues. However, a malignant tumour will interfere with the functioning of surrounding cells. This is the tumour type associated with cancer.
<table>
<thead>
<tr>
<th>Normal</th>
<th>Cancer</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Normal Cells" /></td>
<td><img src="image2.png" alt="Cancer Cells" /></td>
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<tr>
<td><img src="image3.png" alt="Normal Cells" /></td>
<td><img src="image4.png" alt="Cancer Cells" /></td>
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<tr>
<td><img src="image5.png" alt="Normal Cells" /></td>
<td><img src="image6.png" alt="Cancer Cells" /></td>
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</tbody>
</table>

- **Normal**
- **Cancer**

- Large, variably shaped nuclei
- Many dividing cells;
- Disorganized arrangement
- Variation in size and shape
- Loss of normal features
Mutations and Cancer

The changes in the DNA sequence are known as mutations. Depending on the type of change, they may have no effect, a positive effect, or a negative effect.
Mutations and Cancer

- Multiple mutations with different effects can also build upon one another to eventually have a compounded effect.
Mutations and Cancer

- These changes in DNA can be random but there are also certain environmental factors that can increase the likelihood of mutation. These are known as carcinogens.
Mutations and Cancer

- Other factors, such as genetics, can also contribute to the likelihood of developing cancer.
Know Your Breast Cancer Risk

80%

If you have a BRCA1 mutation, your lifetime risk for developing breast cancer is up to 80 percent.

age 25

The risk really picks up after age 25, so women with this mutation should be screened with MRI and mammograms every single year starting at an early age.

Classical BRCA1 Pedigree

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Zygote Formation

- When a sperm and an egg cell fuse together, they form a zygote. This is the single cell that will give rise to the rest of the cells through mitosis.
Zygote Formation

However, if mitosis produces identical cells, how do we get all the different types of cells in a multicellular organism?
Cell Differentiation

A specialized cell is a cell that has a specific structure and function. Cellular differentiation is the process by which a cell becomes specialized to perform a specific function.
Stem Cells

- A stem cell is an undifferentiated cell. When the zygote is formed, it can be considered a totipotent stem cell, which have the ability to differentiate into any cell type.
Stem Cells

- During embryonic development, cells become pluripotent stem cells. These cells can still differentiate into any cell type in the body but not the placenta for the embryo.
As these pluripotent cells become more specialized, they become multipotent stem cells which can only develop into a few specialized cells within a certain tissue type.
Uses for Stem Cells

- Early embryonic stem cells are considered to be totipotent or pluripotent. Adult stem cells are considered multipotent.
Uses for Stem Cells

- Blood found in the umbilical cord after birth can also be a source of multipotent stem cells. Parents may have the option to bank the cord blood for future emergencies because these cells are able to differentiate into different types of blood cells.
Uses for Stem Cells

- For example, leukemia is a cancer that affects white blood cells. Traditionally, chemotherapy destroys the diseased cells before they are replaced with healthy bone marrow from a donor.
Uses for Stem Cells

- However, stem cells from umbilical cord blood can also be used as they can differentiate into different types of blood cells.