Specialized Cells

How does a single fertilized cell (i.e. a zygote) become a human being with ~ 250 types of specialized cells—bone cells, nerve cells, brain cells, muscle cells, etc.?

All of these cells arose from a single cell (the zygote) with a single set of DNA instructions.
How is this possible ?

This is because the original cell became specialized as it divided and multiplied through mitosis, which results in daughter cells with identical genetic information.
As the human body grows, cells that start out being the same undergo *cell differentiation*, which results in cells becoming specialized for the tissue they form and the function they serve.

These cells are referred to as *specialized cells*: i.e. cells that have physical and chemical differences that allow them to perform one job/ one function.

specialized cell: a cell that can perform a specific function.

Cell specialization: the process by which cells develop from similar cells into cells that have specific functions within a multicellular organism.

cell differentiation: a stage of development of a living organism during which specialized cells form.

All cells in the human body have the same complement of DNA, but yet each type of cell is different, e.g. a muscle cell is different to a brain cell. Why?

All cells in the human body have the same complement of DNA, but in different cells, different parts of the DNA are turned on and off. One DNA is turned on in one cell type and another DNA is turned on in another cell type.

It is the active section of the DNA that determines the *shape* and *function* of the cell. The cell is then said to be specialized for a given task.

For example:
— the DNA of a liver cell would have very different parts of its DNA turned on compared to a muscle cell,
— a nerve cell has long, thin structures that function like wires in transmitting electric signals;
— a cardiac muscle is long, thin rectangles with cells attached front to back, so that the long cells may shorten to contract muscle;
—a neuron is star-shaped with long thin fibres which are like wires that send nerve signals.

Hence, specialized cells have a specific size, shape, and area of activated DNA that allows them to perform a specific function.

Almost all body cells are specialized in some way. Specialized cells can look very different from each other. They differ internally as well as externally. For example, a muscle cell will have a lot of mitochondria organelles; whereas cells that produce mucus in the intestine have many Golgi bodies.

Thus, complex organisms have organs and organ systems that perform very different, specialized functions. Different functions require specialized cell types.

Some examples of specialized cells and their functions are given in the table below:

Cell type	Special functions
red blood cells	to carry oxygen in the blood
skin cells	to form a protective layer over the body, and reduce water loss
bone cells	to collect oxygen and form bones
muscle cells	to contract, allowing movement
white blood cells	to fight bacteria and attack infection
nerve cells	to conduct electrical impulses and to transmit a message from one part of the body to another

Plant cells specialize in different ways in some cases: plant cells have special cells for water transport, they have cells with chloroplast for photosynthesis, they also have guard cells to prevent water loss in leaves.

Single celled organisms do not show specialization: with only one cell, they cannot specialize.

Assignment

1. How do cells specialize?
2. Why are complex organisms made up of specialized cells?
3. Every cell in your body came from one fertilized egg cell. What does this tell you about the DNA differences between one body cell and another?
4. Why do single celled organisms not show specialization?
5. What is an example of a specialized cell that has a particular shape and structure that helps it function?
6. Single celled organisms _____ _____ show specialization.
7. Specialized cells that produce mucus have many:
   a. Golgi bodies b. mitochondria c. vacuoles d. nuclei
8. Specialized cells that use a lot of energy, such as muscle cells, have a lot of:
   a. Golgi bodies b. mitochondria c. vacuoles d. nuclei
9. Do all animal cells look the same? Explain.
10. Explain how the structure of the following cells suit their function:
    a. a nerve cell

    b. a red blood cell

    c. a photosynthetic cell