

## **Cell structures and functions questions**

### **1. What is a cell:**

**Cells** A cell is the smallest unit of life that can survive and reproduce on its own, given information in DNA, energy, and raw materials. Some cells live and reproduce independently. Others do so as part of a multicelled organism.

### **2. When and who Discover the cells?**

In the middle of the 17th century, one of the pioneers of microscopy, Robert Hooke (1635–1703), decided to examine a piece of cork tissue with his home-built microscope. He saw numerous box shaped structures that he thought resembled row of empty boxes or rooms, so he called them cells’.

### **3. What is cell theory?**

Cell theory asserts that the cell is the constituent unit of living beings. Before the discovery of the cell, it was not recognized that living beings were made of building blocks like cells. The cell theory is one of the basic theories of Biology.

### **4. Are there living beings without cells?**

Viruses are considered the only living beings that do not have cells. Viruses are constituted by genetic material (DNA or RNA) enwrapped by a protein capsule. They do not have membranes and cell organelles nor do they have self-metabolism.

### **5. What are the two big groups into which cells are classified?**

Cells can be classified as eukaryotic or prokaryotic. Prokaryotic cell is that without a delimited nucleus. Eukaryotic cells are those with nucleus delimited by membrane.

### **6. Do bacteria cells have a nucleus?**

In bacteria the genetic material is dispersed in the cytosol and there is no internal membrane that delimits a nucleus.

### **7. Are there any bacteria made of more than one cell?**

There are no pluricellular bacteria. All bacteria are unicellular prokaryotic.

### **8. What is the plasma membrane of the cell? What are its main functions?**

The plasma membrane is the outer membrane of the cell, it delimits the cell itself and a cell interior with specific conditions for the cellular function. Since it is selectively permeable, the plasma membrane has an important role for the passage of substances inwards or outwards.

### **9. What are the chemical substances that compose the plasma membrane?**

The main constituents of the plasma membrane are phospholipids, proteins and carbohydrates. The phospholipids, amphipathic molecules, are regularly organized in the membrane according to their polarity: two layers of phospholipids form the lipid bilayer with the polar part of the phospholipids pointing to the exterior of the layer and the non-polar phospholipid chains in the interior. Proteins can be found embedded in the lipid bilayer and there are also some carbohydrates bound to proteins and to phospholipids in the outer face of the membrane.

### **10. What is the difference between plasma membrane and cell wall?**

Plasma membrane and cell wall are not the same thing. Plasma membrane, also called cell membrane, is the outer membrane common to all living cells and it is made of a phospholipid bilayer, embedded proteins and some appended carbohydrates.

Because cell membranes are fragile, in some types of cells there are even outer structures that support and protect the membrane, like the cellulose wall of plant cells and the chitin wall of some fungi cells. Most bacteria also present an outer cell wall made of peptidoglycans and other organic substances.

**11. Which type of cell came first in evolution - the eukaryotic cell or the prokaryotic cell?**

This is an interesting problem of biological evolution. The most accepted hypothesis asserts that the more simple cell, the prokaryotic cell, appeared earlier in evolution than the more complex eukaryotic cell. The endosymbiotic hypothesis, for example, affirms that aerobic eukaryotic cells appeared from the mutualist ecological interaction between aerobic prokaryotes and primitive anaerobic eukaryotes.

**12. What are the three main parts of a eukaryotic cell?**

The eukaryotic cell can be divided into two main portions: the cell membrane that separates the intracellular space from the outer space physically delimiting the cell; the cytoplasm, the interior portion filled with cytosol (the aqueous fluid inside the cell); and the nucleus, the membrane-delimited internal region that contains the genetic material.

**13. What are the main structures within the cell nucleus?**

Within the cell nucleus the main structures are: the nucleolus, an optically dense region, spherical shaped, where there are concentrated ribosomal RNA (rRNA) associated to proteins (there may be more than one nucleolus in a nucleus); the chromatin, made of DNA molecules dispersed in the nuclear matrix during the cell interphase; the karyotecha, or nuclear membrane, the membrane that delimits the nucleus.

**14. What are the substances that constitute the chromatin? What is the difference between chromatin and chromosome?**

The chromatin, dispersed in the nucleus, is a set of filamentous DNA molecules associated to nuclear proteins called histones. Each DNA filament is a double helix of DNA and thus a chromosome.

**15. Where in the cell can ribosomes be found? What is the main biological function of ribosomes?**

Ribosomes can be found free in the cytoplasm, adhered to the outer side of the nuclear membrane or associated to the endoplasmic reticulum membrane defining the rough endoplasmic reticulum. Ribosomes are the structures where protein synthesis takes place.

**16. Why can mitochondria be considered the power plants of the aerobic cells?**

Mitochondria are the “power plants” of aerobic cells because within them the final stages of the cellular respiration process occurs. Cellular respiration is the process of using organic molecule (mainly glucose) and oxygen to produce carbon dioxide and energy. The energy is stored in the form of ATP (adenosine triphosphate) molecules and later used in other cellular metabolic reactions. In mitochondria the two last steps of the cellular respiration take place: the Krebs cycle and the respiratory chain.

**17. What are chloroplasts? What are the main function of chloroplasts?**

Chloroplasts are organelles present in the cytoplasm of plant and algae cells. Like mitochondria, chloroplasts have two boundary membranes and many internal membranous sacs. Within the organelle there are DNA, RNA and ribosomes and also the pigment chlorophyll, responsible for absorption of photic energy that is used in photosynthesis.

The main function of chloroplasts is photosynthesis: the production of highly energetic organic molecules (glucose) from carbon dioxide, water and light.

**18. What is the molecule responsible for the absorption of photic energy for photosynthesis? Where is that molecule located in photosynthetic cells?**

The chlorophyll molecules are responsible for the absorption of light energy for photosynthesis. These molecules are found in the internal membranes of chloroplasts.

**19. What is the path followed by the energy absorbed by plants to be used in photosynthesis?**

The energy source of photosynthesis is the sun, the unique and central star of our planetary system. In photosynthesis the solar energy is transformed into chemical energy, the energy of the chemical bonds of the produced glucose molecules (and of the released molecular oxygen). The energy of glucose is then stored as starch (a glucose polymer) or it is used in the cellular respiration process and transferred to ATP molecules. ATP is consumed in metabolic processes that spend energy (for example, in active transport across membranes).

**20 Of what substance is the plant cell wall made? Of which monomer is it made?**

The plant cell wall is made of cellulose. Cellulose is a polymer whose monomer is glucose. There are other polymers of glucose, like glycogen and starch.

**21. What is the function of the plant cell wall?**

The plant cell wall has structural and protective functions. It plays an important role in the constraint of the cell size, preventing the cell to break when it absorbs a lot of water.

**CELL CYCLE (QUESTIONS)**

**1. What is mitosis? What is the importance of mitosis?**

Mitosis is the process in which one eukaryotic cell divides into two cells identical to the parent cell (generally identical, since alterations in genetic material can occur, more or less organelles may be distributed between the daughter cells, etc.). Mitosis is fundamental for asexual reproduction of eukaryotes, for the embryonic development, for the growth of pluricellular beings and for tissue renewal.

**2. Why in some cases is mitosis a synonym of reproduction?**

In some living beings asexual reproduction occurs by many means: binary division, schizogony, budding, grafting, etc. In asexual reproduction of eukaryotes mitosis is the mechanism by which the constituent cells of the new beings are made. The term mitosis does not apply to prokaryotes since it involves nuclear division and eukaryotic structures.

**3. What is the importance of mitosis for the embryonic development?**

Every embryo grows from a single cell that suffers mitosis and generates other cells that also divide themselves by mitosis forming tissues and complete organs. The perfect regulation and control of each of those cell divisions are fundamental for the creation of a normal individual. Without mitosis the embryonic development would be impossible.

**4. What are some examples of organs and tissues where mitosis is more frequent, less frequent or practically absent?**

Generally in vertebrates mitosis is more frequent in tissues that require intense renewing due to their functions, like epithelial tissues and the bone marrow. In plants the meristem tissue has numerous cells undergoing mitosis. Mitosis take place with low frequency in tissues of slow renovation, like the bones in adults and the connective tissues.

In some adult tissues mitosis is almost absent, like the nervous tissue and the striated muscle tissue (skeletal and cardiac). The nervous tissue develops from stimulus by development of new electrical networks between cells and the striated muscle tissue grows by cellular hypertrophy.

**5. How does mitosis participate in the growth of pluricellular organisms?**

All pluricellular beings grow with the increase in quantity of their cells. This increase is produced by mitosis (although some types of growth occur by cellular hypertrophy or by deposition of substances in interstitial spaces).

**6. What is the uncontrolled mitotic process that occurs as disease in pluricellular beings called?**

Uncontrolled mitotic cell division is called neoplasia. Neoplasia (the formation of new strange tissues) occurs when a cell suffers mutation in its genetic material, loses the ability to control its own division and the failure is transmitted to its descendants.

Cancers are malignant neoplasias. The term malignant means that neoplastic cells can disseminate to distant sites invading other organs and tissues. Neoplasias whose cells cannot disseminate to distant sites are called benign neoplasias.

**8. What is cellular regeneration? How is mitosis related to this process?**

Some tissues are able to regenerate when injured. The liver, for example, regenerates when small pieces of hepatic tissue are removed, bones make new tissues in fracture regions, etc. Some animals, like planarias, are capable of regenerating their bodies when sectioned. In tissue regeneration cellular proliferation happens by mitosis.

**9. What is cell cycle?**

Cell cycle, or mitotic cycle, is the time period that begins when the cell is created and finishes when it is divided by mitosis creating two daughter cells. The cell cycle is divided into interphase and the mitotic phase.

**10. Is cell division happening during the entire cell cycle? What is interphase?**

Cell division properly occurs during the mitotic phase of the cell cycle. During interphase processes that are a preparation to cell division take place, like the duplication of DNA and centrioles. Interphase is the preceding phase and the mitotic is the following phase.

### 11. What are the three periods into which interphase is divided?

Interphase is the preceding phase to the mitotic division. It is divided into three periods, G1, S and G2 (the letter G comes from “gap”, meaning interval or breach, and the letter S comes from “synthesis”, indicating the period in which DNA replicates).

In fact, “gap” is not totally appropriate for the periods immediately before and after the DNA synthesis. The idea of “growth” would be more adequate since in those periods (G1 and G2) the cell is growing to divide later in mitosis.

### 12. Describe the Differences between Mitosis and Meiosis

<b><i>Mitosis</i></b>	<b><i>Meiosis</i></b>
Takes place in most cells	Takes place only in sex cell
One cell Two cells	One cell Four cells
Original diploid cell Two new diploid cells	Original diploid cell Four new haploid cells
Original cell is same in genetic content as new cells	Original cell is not same in genetic content as new cells

### 13. Describe the Types of Reproduction

Reproduction is the process whereby all living organisms produce offspring. There are basically two types of reproduction: sexual and asexual reproduction.

#### **Sexual Reproduction**

In sexual reproduction, two special sex cells unite. These reproductive cells are called gametes. In some species, the gametes are alike. However, in many species the two gametes are different. In this case, one is called a male gamete, or sperm. The other is called a female gamete, or egg. Usually a male parent reproduces the sperm and female parent produces the egg. However, some species can produce both sperm and egg in one individual. Such individuals are called hermaphrodites. The earthworm is a hermaphrodite as are many species of snails. Most flowering plants are also hermaphrodite. They produce male and female gametes in each flower. When a male gamete unites with a female gamete, a cell results that is called a zygote. The process by which gametes unite is called fertilization.

#### **Asexual Reproduction**

Asexual reproduction is the formation of a new individual from cells of the parent, without the union of gametes (sex cells, sperm and egg), meiosis, gamete formation, or fertilization. The offspring of organisms that reproduce asexually are genetically identical to their parents and to each other. Without sexual reproduction, the species cannot benefit from the variability introduced

by mixing genes. Therefore, evolutionary adaptation to changing environmental conditions may proceed slowly.

#### **14. Describe the types of asexual reproduction.**

The following are the types of asexual reproduction

**1. Binary Fission:** Binary fission is the simplest form and involves the division of a single organism into two complete organisms, each identical to the other and to the parent. Fission is common among unicellular organisms such as bacteria, many protists, some algae such as *Spirogyra* and *Euglena*, as well as a few higher organisms such as flatworms and certain species of polychaete worms.

**2. Regeneration:** A similar form of asexual reproduction is regeneration, in which an entire organism may be generated from a part of its parent. The term regeneration normally refers to **re-growth** of missing, or damaged body parts in higher organisms, but whole body regeneration occurs in *Hydra*, starfish, and many plants.

**3. Asexual Spore:** Spores are another form of asexual reproduction and are common among bacteria, protists, and fungi. Spores are DNA-containing capsules capable of sprouting into new organisms; unlike most seeds, spores are produced without sexual union of gametes, that is, reproductive cells.

**4. Budding:** Budding is another method of asexual reproduction in which a group of self-supportive cells sprouts from and then detaches from the parent organism. Unlike eggs or spores, buds are multicellular and usually contain more than one cell layer. *Hydra* and sea squirts reproduce by budding.

**5. Vegetative Reproduction:** Vegetative reproduction is common among plants and consists of certain parts that grow out from a main parent plant and eventually root and sprout to form new, independent plants. Examples are the runners of strawberries, the tubers of potatoes, and the bulbs of onions.

**6. Parthenogenesis:** Parthenogenesis is an important means of asexual reproduction in which new individuals are formed from unfertilized eggs. It occurs in some insects, amphibians, reptiles, and birds and in some species of plants.