**Extracellular matrix and Cytoskeleton worksheet**

**Note that this chapter is not included in the control program**

**Exercice 1: For each question choose only one answer**

**The correct answer is underlined and colored in red**

1. **Which of the following statements is correct?**
2. Bacterial cells secrete materials that form an extracellular matrix [**Bacterial** **cells are surrounded by a rigid cell wall and do not have ECM because they are unicellular organisms]**
3. **Extracellular matrix provides, structural support and helps to organize cells**
4. Animal cells are surrounded by a rigid cell wall that provides structure and support [**Unlike the cells of Bacteria, Fungi, and Plants, the cells of animals are not surrounded by a rigid cell wall]**
5. The extracellular matrix is secreted by all Eukaryotic cells **[ no , only multicellular organisms secrete ECM, Eukaryotic unicellular organisms like Protists and fungi do not have ECM]**
6. **The extracellular matrix is:**
7. Located inside cells [**the interior of the cell is occupied by the cytoplasm and the nucleus]**
8. **Found between cells**
9. Only present in skin tissue [**No, the extracellular matrix is ​​present in the majority of tissues: bone, skin, different epithelia, etc**.]
10. A cellular organelle [**No, it is not a cell organelle. It is a crowded system containing water, mineral and macromolecules such as fibrous proteins, polysaccharides**]
11. **Which of the following statements best describes the extracellular matrix**
12. **In general it is the non-cellular components within animal tissues and organs**
13. It contains approximately equal quantities of lipids and proteins [**this describes the composition of the cell membrane. The cytoplasmic membrane is formed of approximately 50% proteins and 50% lipids**]
14. It only serves to separate the cells of a tissue [**The Extra Cellular Matrix found in animals performs many important roles, including strength, structural support, organization, and cell signaling]**
15. Its composition and physical properties are always the same, regardless of the tissue type, its location, and its physiologic state. [**The composition and physical properties of the Extracellular Matrix, can vary depending on the tissue type, its location, and its physiologic state]. +3**
16. **Major components of the ECM include**
17. **Fibrous proteins**
18. Globular proteins [**The most abundant proteins are those that form large fibers.]**
19. Peptidoglycan [**The** **peptidoglycan, a polymer of modified sugars cross-linked by short polypeptides, is a constituent of the bacterial wall]**
20. Ribosomes [**are nonmembranous intracellular organelles responsible for the synthesis of proteins**]
21. **Which of the following is not a component of the extracellular matrix**
22. Fibrous proteins [**They represent the most abundant proteins in the ECM]**
23. Glycosaminoglycans [**They represent the most abundant types of ECM polysaccharides, among vertebrates]**
24. Proteoglycans [**The majority of glycosaminoglycans in the Extracellular matrix are linked to core proteins, forming proteoglycans]**
25. **Glycogen**
26. **The ECM’s primary functions include:**
27. **Mechanical support for cell anchorage**
28. Synthesis of extracellular matrix proteins [**Extracellular matrix proteins are synthesized and secreted by cells of epithelial tissue**]
29. DNA replication and cell division [**These functions require the intervention of the cell nucleus**]
30. Cell motility [**This function involves the cytoskeleton**]
31. **Polysaccharides**
32. Are the first major component, of the ECM of animals.[**Polysaccharides are the second major component (After proteins), of the extracellular matrix of animals]**
33. Among vertebrates, the most abundant types in the ECM are peptidogycans **[the most abundant types in the ECM are glycosaminoglycans (GAGs)].**
34. **Provide a pathway for diffusion of water soluble traffic between the blood and tissue cells.**
35. Their hydrated gel-like nature is primarily due to collagen [**Their hydrated gel-like nature is primarily due to Glycosaminoglycans which are highly negatively charged molecules and tend to attract positively charged ions and water]**
36. **Glycosaminoglycans**
37. are highly positively charged [**Glycosaminoglycans are highly negatively charged molecules]**
38. have an important elasticity [Elastin molecules have an important elasticity]
39. are found abundantly in tissues that must be capable of easily stretching and then recoiling [**This is a characteristic of elastin fibers, while for Glycosaminoglycans they are rather found are found abundantly in regions of the body that are subjected to harsh mechanical forces, such as the joints of the human body].**
40. **contribute to tissue hydration due to their watery gel-like property**
41. **Which one is a glycosaminoglycan?**
42. **Hyaluronic acid**
43. Elastin **[Elastin is a structural protein]**
44. Collagen **[Collagen is a structural protein]**
45. Laminin **[Laminin is an adhesive protein]**
46. **The main function of hyaluronic acid is :**
47. Protein synthesis [**Ribosomes are responsible for the synthesis of proteins from individual amino acids**].
48. Energy production [**Mitochondria is the organelle responsible for aerobic cellular respiration and energy production]**
49. **Tissue hydration**
50. Hormone production [ **Endocrine glands are responsible for hormone production**]
51. **ECM proteoglycans**
52. **Provide resistance to compression**
53. Once secreted from cells, these macromolecules form a fibrous component in the ECM. **[they form a watery gel-like component]**
54. Are formed from peptidoglycans linked to core proteins [**proteoglycans are formed from glycosaminoglycans linked to a core protein**]
55. Are a fibrous proteins. [**No, they are not fibrous proteins. Proteoglycans consist of a core protein and one or more covalently attached GAG chains]**
56. **The hydrated gel-like nature of ECM is primarily due to**

a) Collagen [**collagen provides tensile strength to tissues]**

b) Elastin [**Elastin is a protein fiber with remarkable elastic properties]**

**c) Glycosaminoglycans**

d) Fibronectin [**promotes cell adhesion and holds cells in position]**

1. **Collagen**
2. Is the most abundant fibrous protein in the plant kingdom [**Collagen is the most abundant fibrous protein in the animal kingdom].**
3. **Forms cable-like fibres or sheets that provide tensile strength (resistance to longitudinal stress).**
4. from the Greek, meaning gel producing [**Collagen (from the Greek, meaning glue producing]**
5. Is a globular protein. **[collagen is a fibrous protein]**
6. **In bone tissue, collagen provides**:
7. Flexibility [**no,** **collagen provides resistance to longitudinal stress]**
8. Resistance to the stretching force [**this is one of the properties of elastin which can be stretched and relaxed]**
9. **Tensile strength**
10. Electrical conductivity **[electrical conductivity is one of the properties of nervous tissue]**
11. **Collagen synthesis requires which vitamin:**
12. Vitamin A
13. Vitamin B
14. **Vitamin C** [**Vitamin C is essential to the formation of collagen]**
15. Vitamin D
16. **Which component provides the most tensile strength to the ECM ?**
17. Elastin [**elastin fibers provides resistance to stretching forces, they are like a rubber band, stretching under tension and snapping back when the tension is released].**
18. **Collagen**
19. Laminin [**Lamnin connects cells to the Extracellular Matrix]**
20. Fibronectin **[Fibronectin provides anchorage of cells to the extracellular matrix.]**
21. **Elastin’s main characteristic is :**
22. Rigidity **[this is one of the properties of collagen, indeed, Many rodlike collagen molecules are cross-linked together in the extra cellular space to form unextendable collagen fibrils that have the tensile strength of Steel]**
23. **Elasticity**
24. Watery gel-like property **[this is a property of the glycosaminoglycan]**
25. Resistance to compression **[this is a property of collagen, Polysaccharides and proteoglycans of the ECM]**
26. **Elastin is particularly important in :**
27. Hair
28. **Lungs [Elastin is most abundant in tissues that must be capable of easily stretching and then recoiling after the stretching force is removed. It is found, for example, in the lungs, which stretch and recoil as air moves in and out].**
29. Bones
30. Teeth
31. **The elastic properties of elastin are due to :**
32. Its long, unbranched structure [**this is the structure of the glycosaminoglycans (GAGs) which are a long, unbranched polysaccharides].**
33. its highly negative charge [**Glycosaminoglycans are highly negatively charged molecules]**
34. **Its ability to stretch and recoil [Elastin proteins form many covalent cross-links to make a fiber with remarkable elastic properties]**
35. Its nuclear location **[Elastin is located in the extracellular matrix]**
36. **Laminin is primarily found in :**
37. **Basal lamina**
38. Nuclear lamina [**lamin is the** **primarily protein found in the nuclear lamina]**
39. Cell membrane **[Laminin is an extracellular matrix protein]**
40. Golgi apparatus **[laminin is found in the extracellular matrix]**

**Exercise 2: For each question multiple answers are possible**

1. **The main functions of fibronectin are :**
2. Tissue hydration
3. **Cell adhesion**
4. Resistance to compression
5. **To bind other components of the extracellular matrix and cell adhesion molecules**
6. **GAGs are characterized by (multiple answers) :**
7. **Repeated disaccharide units**
8. **High negative charge**
9. **Ability to bind water**
10. Protein synthesis
11. **The basal lamina is (multiple answers) :**
12. **a specialized part of the extracellular matrix**
13. **located adjacent to the epithelial cells**
14. **mainly composed of laminin**
15. located right beneath the inner nuclear membrane [**the nuclear lamina is located right beneath the inner nuclear membrane**]
16. **Which of the following statements is correct? (Multiple answers):**
17. **Laminin connects cells to the Extracellular Matrix**
18. Laminin is a primary component of the cell membrane [**No, Laminin is a primary component of the basal lamina]**
19. **Reduced amounts of fibronectin have been found within certain types of cancerous tissue [possibly accounting for the fact that cancer cells do not adhere well to each other but tend to break loose and metastasize (spread elsewhere in the body)].**
20. **fibronectin promotes cell adhesion and holds cells in position**
21. **ECM proteins (Multiple answers):**
22. The most abundant are those that form globular proteins [**The most abundant proteins are those that form large fibers]**
23. **Can be grouped into structural proteins and Adhesive proteins.**
24. **In mammals, more than 25% of the total protein mass consists of collagen**
25. **One of the unique features of fibronectin is its ability to bind a large number of molecules**

**Conceptual Questions (continuous assessment (CA))**

1. Define the extracellular matrix. What are its main components?

**Definition. In general it is the non-cellular components within animal tissues and organs.**

**Like the inside of a cell the extra cellular matrix is very crowded. It contains water, mineral and macromolecules such as fibrous proteins, polysaccharides.**

**Its main components include:**

**Proteins: collagen, elastin fibronectin, and laminin**

**Proteoglycans and glycosaminoglycans (GAGs)**

1. What are the main roles of the extracellular matrix?

**The Extra Cellular Matrix found in animals performs many important roles, including strength, structural support, organization, and cell signaling.**

1. Explain how GAGs contribute to tissue hydration

**Glycosaminoglycans are highly negatively charged molecules that tend to attract positively charged ions and water, due to this property these macromolecules form a watery gel-like component in the extracellular matrix and contribute to tissue hydration**

1. Compare and contrast the mechanical properties of collagen and elastin.

* **Collagen and elastin are structural proteins of the extracellular matrix**
* **Collagen forms cable-like fibers or sheets that provide tensile strength (resistance to longitudinal stress).**
* **Elastin proteins form many covalent cross-links to make a fiber with remarkable elastic properties (it can be stretched and relaxed)**

1. A patient has a mutation in the elastin gene

* What tissues would be most affected?

**Blood vessels, arteries and especially the largest artery-the aorta because Elastin is the dominant extracellular matrix protein in arteries, comprising 50% of the dry weight of the largest artery-the aorta.**