Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 1

Wednesday 19 May 2021 (morning)

1 hour

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The maximum mark for this examination paper is **[40 marks]**.

2221 – 6007

14 pages

1. In mammals, mature red blood cells are specialized in that they lack nuclei, mitochondria or ribosomes. Which statement applies to red blood cells?

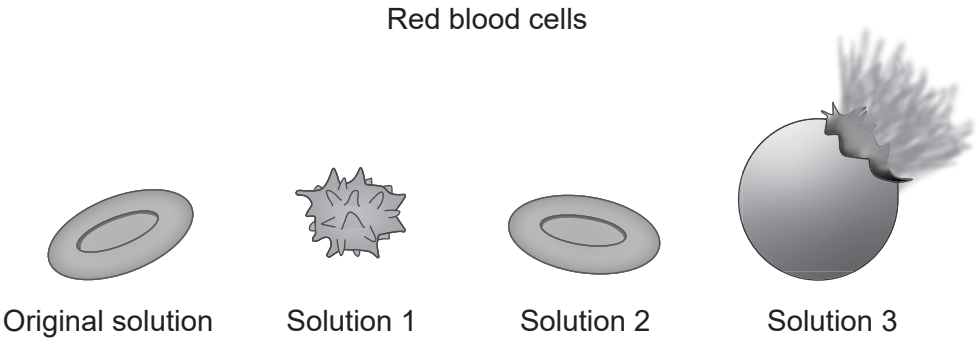
A. No chemical reactions take place within their cytoplasm.

B. They cannot produce new enzymes.

C. Materials cannot enter red blood cells.

D. Materials cannot exit red blood cells.

The images refer to question 2 and question 3. They show samples of red blood cells that were placed in different concentrations of salt solutions.



2. Which process explains the observations shown in the images?

A. Active transport

B. Exocytosis

C. Facilitated diffusion

D. Osmosis

3. Which solution has the highest salt concentration?

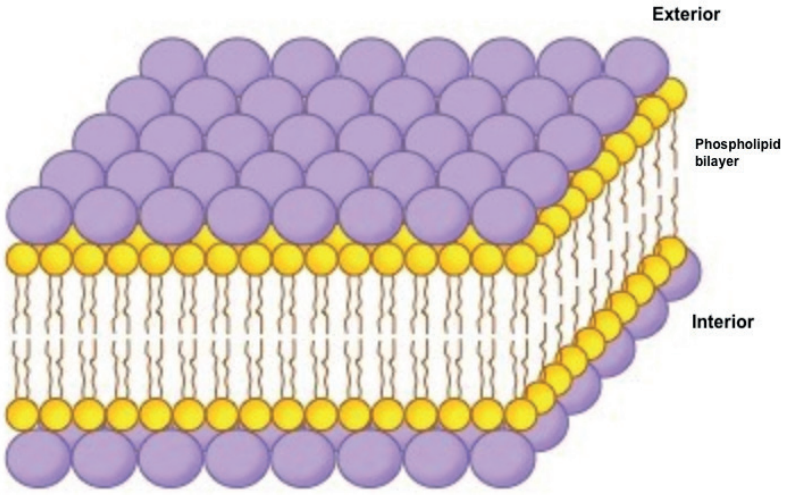
A. The original solution

B. Solution 1

C. Solution 2

D. Solution 3

4. The Davson–Danielli model of membrane structure proposed that membranes were composed of a phospholipid bilayer that lies between two layers of globular proteins, as shown in this diagram.



What evidence supported this model?

A. An electron micrograph that showed two dark lines with a lighter band in between

B. Freeze-fracture electron microscopy

C. Evidence that all membranes are identical

D. The hydrophobic regions of protein would be in contact with water

5. Which living structure is an exception to the cell theory?

A. Striated muscle fibres

B. A single-celled alga carrying out all of the functions of life

C. The artificial synthesis of the organic molecule urea

D. A multicellular organism with cells undertaking specialized roles

6. Which statement applies to cholesterol?

A. It is hydrophobic and found on the outside of the phospholipid bilayer.

B. It is hydrophilic and found inside the phospholipid bilayer.

C. It impacts membrane fluidity.

D. It is transported in association with glucose in the blood.

7. What distinguishes cellulose from glycogen and starch?

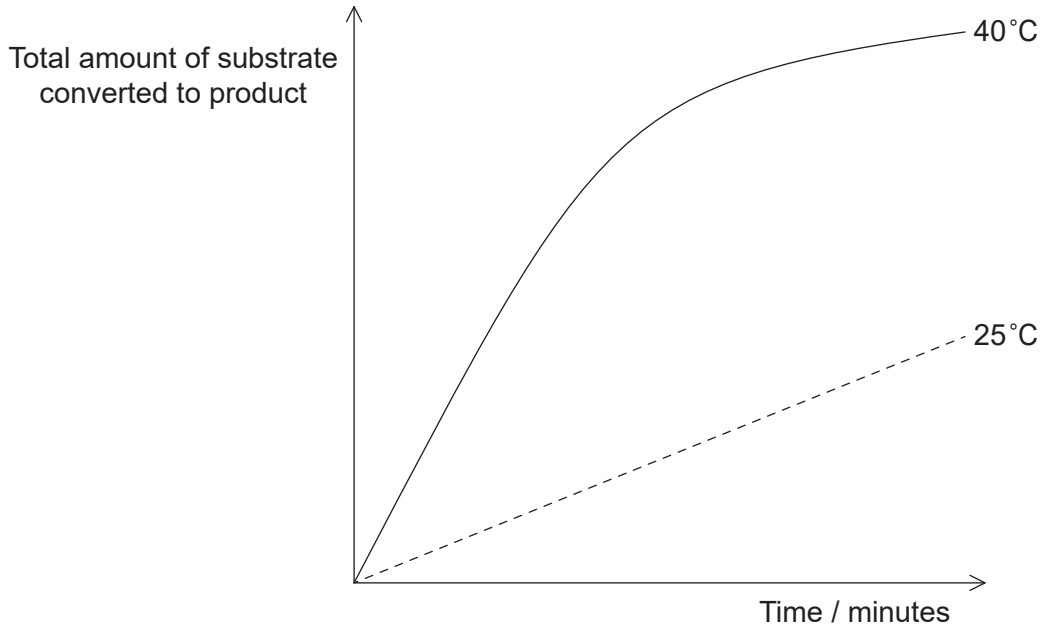
A. Only cellulose is found in plants.

B. Only cellulose is made up of glucose monomers.

C. Cellulose is far more branched than starch and glycogen.

D. Cellulose has a structural role whereas starch and glycogen function in energy storage.

8. The graph shows the progress of the same enzyme-controlled reaction at two different temperatures.



Which statement is clearly supported by the data?

A. The amount of product produced initially occurs at a lower rate at 40 °C

B. The optimum temperature for the reaction is 40 °C

C. The lower the temperature, the slower the rate of the reaction

D. The enzyme is denatured at 40 °C

9. What is a difference between aerobic respiration and anaerobic respiration in yeast?

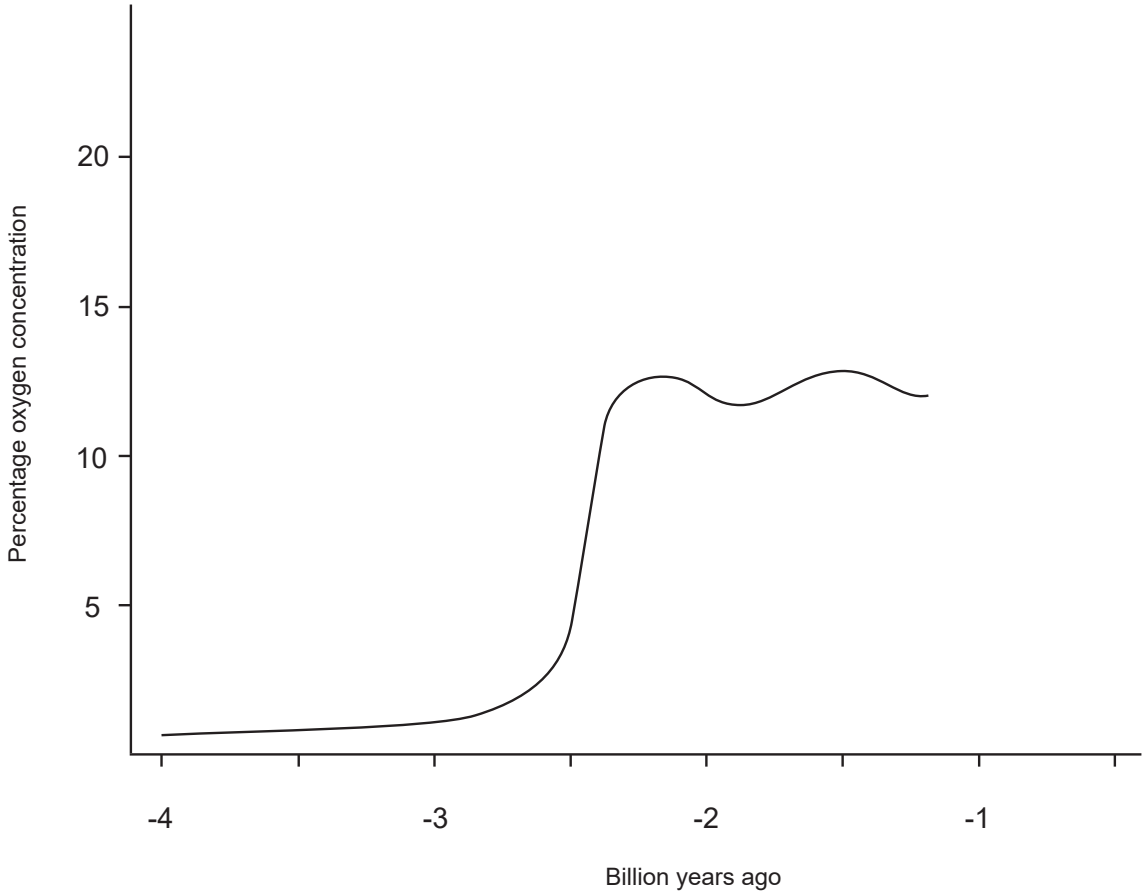
A. Anaerobic respiration requires enzymes, aerobic respiration does not.

B. Anaerobic respiration requires glucose, aerobic respiration does not.

C. Anaerobic respiration produces ethanol, aerobic respiration does not.

D. Anaerobic respiration does not produce oxygen, aerobic respiration does.

10. The graph shows atmospheric oxygen levels over time.



About 2.5 billion years ago, a significant rise in atmospheric oxygen occurred. What was the cause of this rise?

A. Photosynthesis by non-vascular land plants

B. Photosynthesis by vascular land plants

C. Oxygen produced by photosynthetic bacteria being released from the ocean into the atmosphere

D. Volcanic activity

11. Which genotype would be normally found in a gamete?

A. Rr

B. RS

C. rStt

D. TUt

12. Which statement applies to meiosis and mitosis?

A. Meiosis occurs in a greater number of locations in the body compared to mitosis.

B. Separation of chromatids occurs in both meiosis and mitosis.

C. Recombination occurs in both meiosis and mitosis.

D. Reduction in chromosome number occurs in both meiosis and mitosis.

13. Over time, the hull of a sunken ship may become colonized by a wide range of marine organisms. What term is used to describe all of the organisms living in and on a sunken ship?

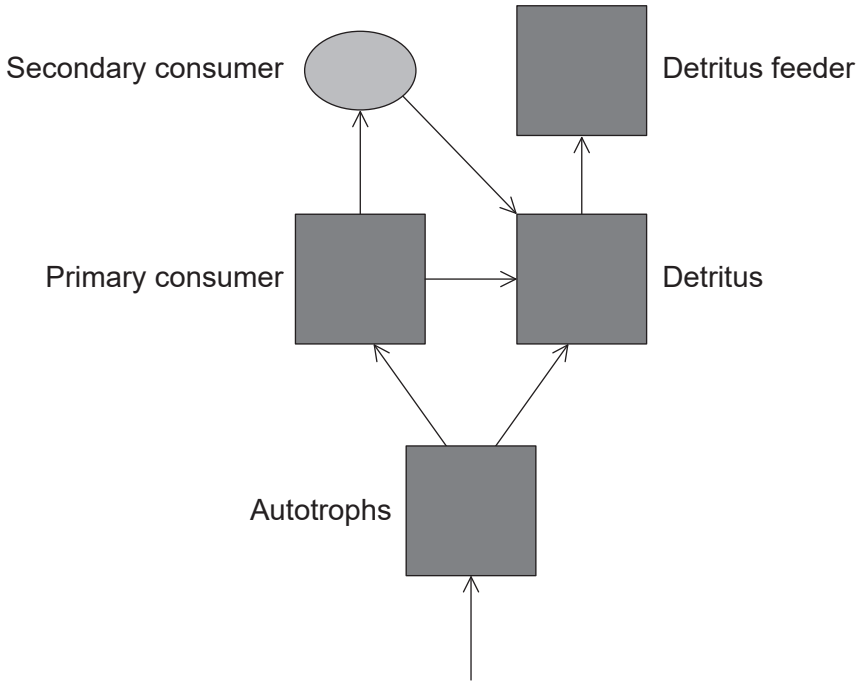
A. A community

B. An ecological niche

C. A population

D. An ecosystem

14. The diagram shows the energy flow between five “sinks” in a terrestrial ecosystem.



In a typical terrestrial ecosystem, which trophic level would have the highest biomass?

A. Autotrophs

B. Primary consumers

C. Secondary consumers

D. Detritus feeders

15. What are the evolutionary origins and functions of homologous structures?

	Evolutionary origin	Function
A.	common or different origin	same function
B.	common origin	same or different function
C.	different origin	same function
D.	different origin	same or different function

16. A locust is an arthropod. For invertebrate groups, which recognition feature is found only in arthropods?

A. Bilateral symmetry

B. Jointed appendages

C. Wings

D. Segmented body

17. A dichotomous key can be used to distinguish four types of plant. Which of the plants could be a bryophyte?

1. Vascular tissue present . . . . . go to 2
   Vascular tissue not present . . . . . Plant A.
2. Produces seeds . . . . . go to 3
   Does not produce seeds . . . . . Plant B.
3. Seeds found in cones . . . . . Plant C.
   Seeds found in fruit . . . . . Plant D.

18. A fluid sample is taken from the digestive tract of a mammal. The sample is basic (alkaline) and able to digest starch and proteins. From which part of the digestive tract was the fluid taken?

A. Mouth

B. Stomach

C. Small intestine

D. Gall bladder

19. An individual was presented with a stimulus resulting in the release of epinephrine. What was the most likely nature of the stimulus?

A. Sunset and the onset of darkness

B. An image of a close friend

C. The intake of glucose

D. A coach shouting to begin physical activity

20. What is a property of arteries?

A. Arteries have elastic walls.

B. Arteries have valves.

C. All arteries carry oxygenated blood.

D. Arteries receive blood from the atria.

21. Which process results in the exchange of gases across the membrane of pneumocytes?

A. Active transport

B. Simple diffusion

C. Facilitated diffusion

D. Mass flow

22. Which statement applies to an axon at rest?

A. There is no electric potential difference between the external and internal surfaces of the plasma membrane.

B. The external surface of the plasma membrane is positive relative to the internal surface.

C. The external surface of the plasma membrane is negative relative to the internal surface.

D. The internal surface of the plasma membrane has a much higher concentration of sodium ions.

23. Which structural feature enables saltatory conduction?

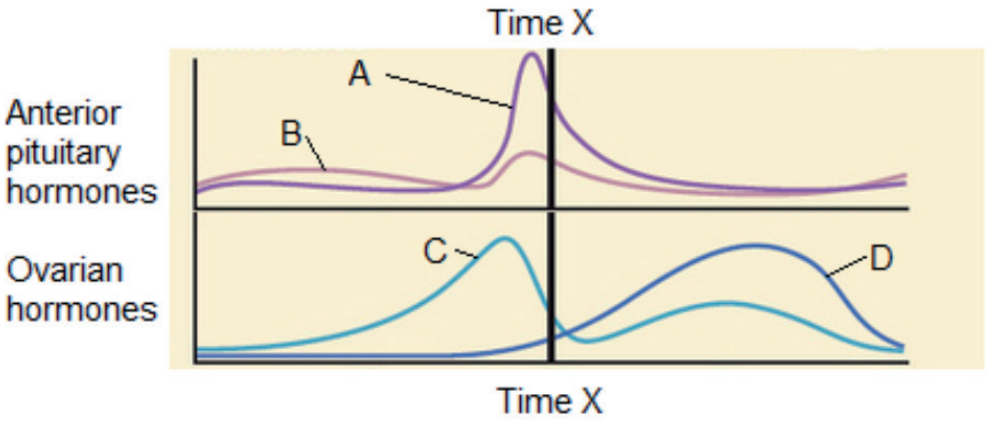
A. Nodes of Ranvier between Schwann cells

B. Na^+ channels under Schwann cells

C. K^+ channels under Schwann cells

D. Sodium–potassium pumps under Schwann cells

The graph showing blood levels of hormones associated with the menstrual cycle refers to question 24 and question 25.



24. Which line on the graph represents progesterone?

A. Line A

B. Line B

C. Line C

D. Line D

25. What event occurs approximately at the time of the dotted line (time X)?

A. Menstruation

B. Ovulation

C. Development of the primary follicle

D. Implantation

26. Which regions of DNA code for the production of specific proteins?

A. Telomeres

B. Genes for ribosomal RNA

C. Exons

D. Regulators of gene expression

27. Which statement applies to tRNA?

A. There is at least one type of tRNA that combines with each known amino acid.

B. One type of tRNA can combine with all of the known amino acids.

C. tRNA carries out its main role within the nucleus.

D. tRNA is produced by the process of translation.

28. Which statement applies to the tertiary structure of enzymes?

A. Tertiary structure is the sequence of amino acids in an enzyme.

B. Some enzymes do not have a tertiary structure.

C. An example of tertiary structure in an enzyme is the alpha helix.

D. A change in the tertiary structure of an enzyme may result in a change in the structure of the active site.

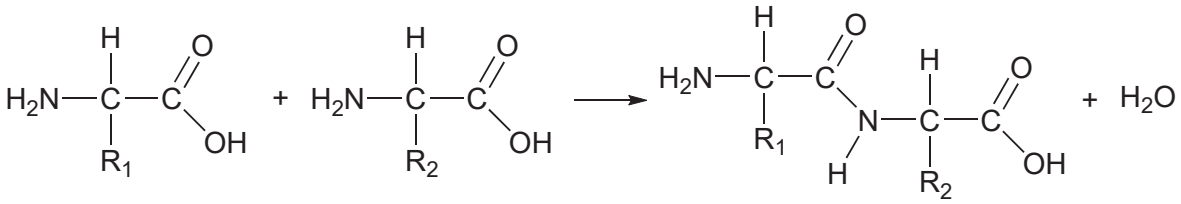
29. Which equation is an example of decarboxylation?

A. $Pyruvate \rightarrow Acetyl\ CoA + CO_2$

B. $CO_2 + H_2O \rightarrow H_2CO_3$

C. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

D.



30. Succinate dehydrogenase is an enzyme that catalyses the oxidation of succinic acid. If malonic acid is added to the mixture, the rate of reaction is reduced. An increase in succinic acid will increase the rate of reaction again. For this system, which term best describes malonic acid?

A. Substrate

B. End product

C. Non-competitive inhibitor

D. Competitive inhibitor

31. What does electron tomography allow mitochondria researchers to do?

A. To produce images of cristae.

B. To produce images of ATP synthase molecules.

C. To trace the movement of electrons through the electron transport chain.

D. To visualize oxidation/reduction reactions.

32. Which process does **not** take place in the stroma of chloroplasts?

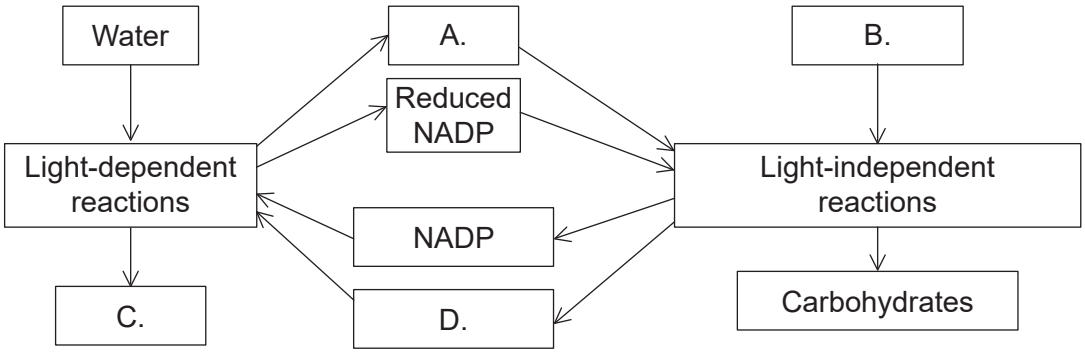
A. Synthesis of carbohydrates

B. Fixation of carbon

C. Reduction of NADP

D. Synthesis of ribulose bisphosphate

33. A summary diagram of photosynthesis is shown. Which molecule represents ATP?



34. Which method can be used to induce short-day plants to flower out of season?

A. Grow them in winter

B. Grow them in summer

C. Expose them to a brief period of light during the night time

D. Cover them with opaque cloth for several hours before sunset

35. Which statement is valid regarding chromatids?

A. Sister chromatids separate during meiosis I.

B. Chiasmata form between non-sister chromatids.

C. Crossing over is the exchange of DNA between sister chromatids only.

D. Non-sister chromatids have the same combination of alleles.

36. In fruit flies (*Drosophila melanogaster*), grey bodies (b^+) are dominant to black bodies (b) and normal wings (vg^+) are dominant to vestigial wings (vg). Homozygous vestigial winged, black bodied flies were crossed with individuals that were heterozygous for both traits. 2300 individuals were counted and the phenotypes observed were recorded as shown.

965 normal wings, grey bodies
944 vestigial wings, black bodies
206 vestigial wings, grey bodies
185 normal wings, black bodies

Which statement is valid?

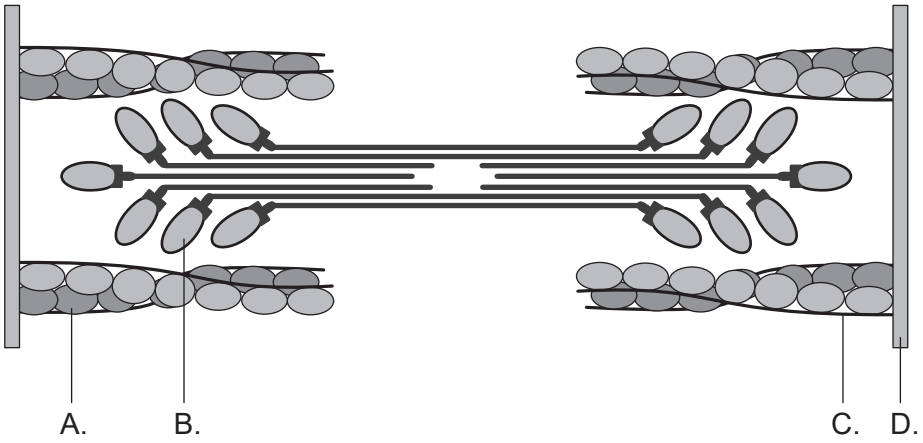
A. The predicted phenotypic ratio was 9 : 3 : 3 : 1.

B. There is independent assortment of wings but not body colour.

C. The expected number of vestigial winged, grey bodied flies was 575.

D. The traits are on different chromosomes.

37. The diagram represents a sarcomere. Which structure is myosin?



38. What is normally found in the urine of a healthy individual?

A. Glucose

B. Red blood cells

C. Proteins

D. Sodium ions

39. The pregnancy test for humans is based on detection of the hormone HCG. What is the reason for detection of this hormone indicating pregnancy?

A. HCG is involved in milk production.

B. HCG production is blocked by negative feedback during menstruation.

C. HCG is produced by an embryo.

D. HCG is released during the acrosome reaction.

40. Expansin is a plant protein that loosens connections between cellulose fibres in plant cell walls, allowing growth. In what location would expression of the expansin gene be expected to be increased?

A. On the shaded side of a shoot being exposed to light

B. On the light side of a shoot being exposed to light

C. On the shaded side of a leaf that is transpiring rapidly

D. On the light side of a leaf that is transpiring rapidly

References:

4. Cornell, B. 2016. https://ib.bioninja.com.au/standard-level/topic-1-cell-biology/13-membrane-structure/membrane-models.html.

24. By OpenStax College - Anatomy & Physiology, Connexions Web site. http://cnx.org/content/col11496/1.6/, Jun 19, 2013, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/), https://commons.wikimedia.org/w/index.php?curid=30148641.

37. MPI of Molecular Plant Physiology. [*Sarcomere*]. [diagram online] Available at: http://www.macroevolution.net/sarcomere.html [accessed 4 April 2019]. Source adapted.