Inside a Muscle Cell

Model the cell structures that support contraction and repair

FB.3.2 "Use models to investigate and explain structures within living cells that support life (e.g., cytoplasm, cell membrane, cell wall, nucleus, mitochondria, chloroplasts, lysosomes, Golgi, vacuoles, ER, ribosomes, chromosomes, centrioles…"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle each cell structure named in the passage, then underline the route for immediate contraction and the route for placing a new channel in the cell membrane.

Two Routes Through a Working Cell

1. Imagine a muscle cell in a runner climbing a hill. A useful cell model shows parts as labeled regions and uses arrows to track changes, not tiny hallways inside the cell. The cell membrane separates the cell from its surroundings and receives a signal from a nerve. Cytoplasm fills the space around the cell's structures. The nucleus holds chromosomes, which contain DNA instructions for making proteins. Its nuclear membrane separates those instructions from the cytoplasm. A model can show where a message starts and where its effects appear, even when the signal and the cell's materials take different paths.

2. When the nerve signal reaches the cell membrane, an electrical change spreads along the membrane. It triggers a specialized smooth endoplasmic reticulum, or ER, to release stored calcium ions into the cytoplasm. Calcium allows contractile proteins inside the cell to interact. Mitochondria use oxygen and products of glucose breakdown to make much of the cell's ATP. ATP powers the movement of the contractile proteins, causing contraction. An arrow from mitochondria to contractile proteins in a model means ATP is available to those proteins. It does not mean the structures are joined by a tube.

3. Repeated activity also wears out some cell parts. To maintain the cell membrane, the cell makes new membrane proteins, including channels that help electrical changes spread. A DNA instruction in the nucleus is copied into a message that leaves through a pore in the nuclear membrane. Ribosomes attached to rough ER read the message and build the protein, which enters the ER. The Golgi apparatus modifies and sorts it into a transport vesicle. When the vesicle joins the cell membrane, the channel is placed there. This route supports future signals, while the calcium and ATP route supports immediate contraction.

2 ANSWER WITH EVIDENCE

Use the passage

1. Trace how a nerve signal leads to contractile proteins interacting. Name the cell membrane, ER, and calcium in order.

2. In a model of contraction, what does an arrow from mitochondria to contractile proteins mean? What should the arrow not suggest?

3. Trace a new membrane channel from its DNA instruction to its place in the cell membrane. Name at least four cell structures along the route.

4. Suppose the Golgi apparatus can no longer sort new proteins. Use the model to predict how this could affect later nerve signals.

3 YOUR TURN

Your own words

Draw two side-by-side models of the same muscle cell, one with plentiful oxygen and one with limited oxygen. In each panel, label the cell membrane, mitochondria, ATP, and contractile proteins, use arrows to show the connections, and write one sentence predicting how well the cell can contract.

Inside a Muscle Cell

PART 1 · READ AND MARK

Circle each cell structure named in the passage, then underline the route for immediate contraction and the route for placing a new channel in the cell membrane. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Trace how a nerve signal leads to contractile proteins interacting. Name the cell membrane, ER, and calcium in order.	**A nerve signal reaches the cell membrane, causing an electrical change. This triggers the specialized smooth ER to release calcium into the cytoplasm, where calcium allows contractile proteins to interact.**
2	In a model of contraction, what does an arrow from mitochondria to contractile proteins mean? What should the arrow not suggest?	**It means ATP made by mitochondria is available to power the contractile proteins. It does not mean the mitochondria and proteins are joined by a tube.**
3	Trace a new membrane channel from its DNA instruction to its place in the cell membrane. Name at least four cell structures along the route.	**The instruction in the nucleus is copied into a message that leaves through a nuclear pore. Ribosomes on rough ER build the protein; the Golgi apparatus sorts it into a vesicle that joins the cell membrane.**
4	Suppose the Golgi apparatus can no longer sort new proteins. Use the model to predict how this could affect later nerve signals.	**Fewer new channels might be placed in the cell membrane, which could make it harder for electrical changes from later nerve signals to spread.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Panel 1, plentiful oxygen: Label the cell membrane, mitochondria, ATP, and contractile proteins. Arrows show oxygen entering across the membrane, mitochondria making ATP, and ATP powering the contractile proteins. Caption: With plenty of oxygen, mitochondria can make ATP that helps power contraction.
Panel 2, limited oxygen: Use the same labels and arrows, but show less oxygen entering and less ATP made by mitochondria. Caption: With less oxygen, mitochondria may make less ATP, so the cell may have less energy for sustained contraction.

Accept models that show ATP powering contractile proteins within the cell. With limited oxygen, students may note that the cell can still make some ATP by other processes.