RUBRIC

PERFORMANCE TASK LESSON 32

Food and Agriculture Center for Science Education

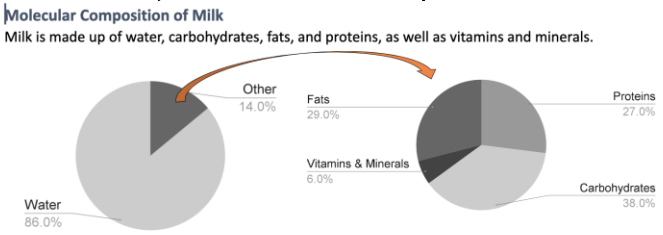
Module 1 Task Rubric

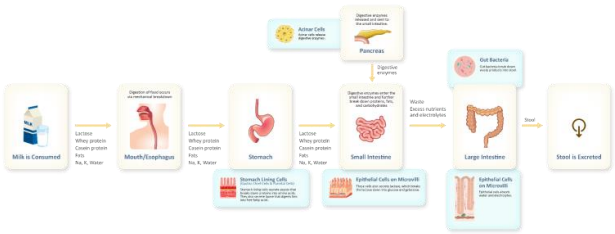
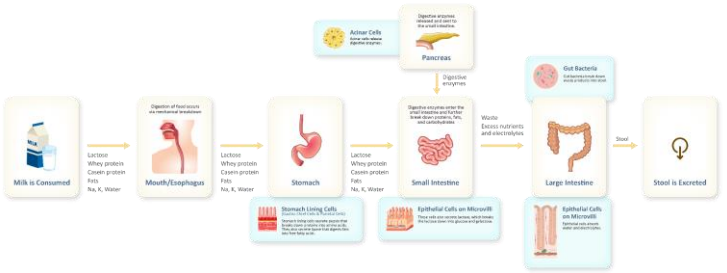
INFO-H5: Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

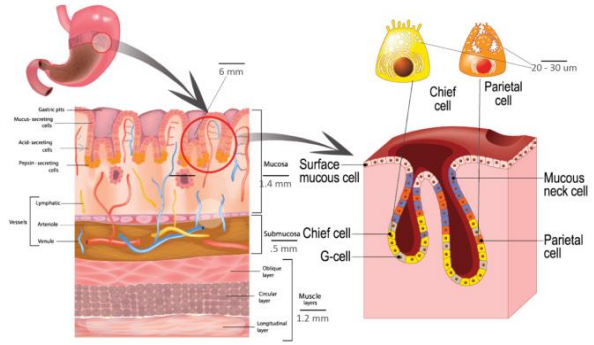
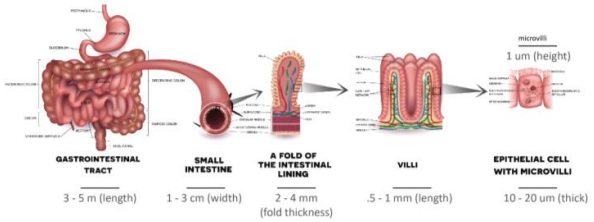
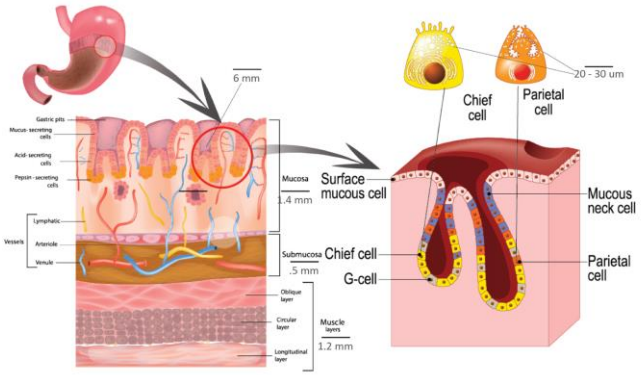
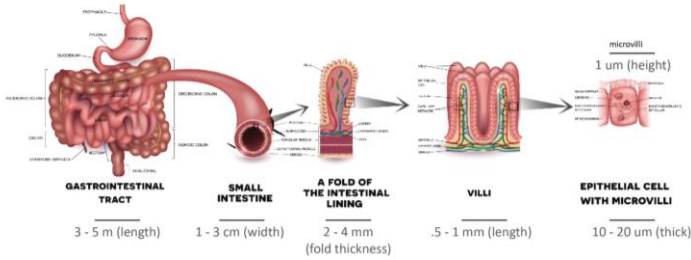
LS1.A-H1: Systems of specialized cells within organisms help them perform the essential functions of life.

LS1.A-H3: Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.

SPQ-H4 Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.

	Emerging	Developing	Proficient
Sample Student Response	Let's start from the beginning. The nutrients that makeup milk, such as fats, lactose, proteins, and electrolytes. When an athlete drinks milk after working out, milk goes into their digestive system, which is made of many different organs, which are each made of many different specialized cells. Each of	Let's start from the beginning. The Chemistry of Milk illustration showed the nutrients that makeup milk, such as fats, lactose, proteins, and electrolytes. When an athlete drinks milk after working out, milk goes into their digestive system, which is made of many different organs, which are each made of many different specialized cells. Each of these has a different job. As we look at our class model, we can see each organ and what is happening in these organs. Let's walk through what happens in each of the steps shown below.	Let's start from the beginning. The Chemistry of Milk illustration showed the nutrients that makeup milk, such as fats, lactose, proteins, and electrolytes.  *Milk Chemistry*. Milk Chemistry - Cheese Science Toolkit. (n.d.). https://www.cheesescience.org/milk.html When an athlete drinks milk after working out, milk goes into their digestive system, which is made of many different organs, which are each made of many different specialized cells. Each of these has a different job. As we

	these has a different job. Starting at the mouth, nutrients pass through the esophagus and move into the stomach. This is where the digestion of milk really begins. When nutrients reach the athlete's stomach, we start to see how specialized cells are working to digest milk. The lining of the stomach has specialized cells that start acting upon nutrients with enzymes. Fats are broken down from big globules to smaller globules by gastric lipase. Proteins are broken down into amino acids by pepsin, which is an enzyme released from Chief cells in the stomach lining. Then, nutrients from milk move into the athlete's small intestine. More chemical digestion happens as an enzyme called lactase breaks lactose down into	 Starting at the mouth, nutrients pass through the esophagus and move into the stomach. This is where the digestion of milk really begins. When nutrients reach the athlete's stomach, we start to see how specialized cells are working to digest milk. The lining of the stomach, which is about 6mm in size, has specialized cells that start acting upon nutrients with enzymes. We can see from our size & orders of magnitude tool that the cells of the stomach are 1.0-1.6 mm m in size. Fats are broken down from big globules to smaller globules by gastric lipase. Proteins are broken down into amino acids by pepsin, which is an enzyme released from Chief cells in the stomach lining. The enzyme is much smaller than the cells at 5-10 nm in size. So, we can see that different structures of different sizes make up this complex system.	look at our class model, we can see each organ and what is happening in these organs. Let's walk through what happens in each of the steps shown below.  Starting at the mouth, nutrients pass through the esophagus and move into the stomach. This is where the digestion of milk really begins. When nutrients reach the athlete's stomach, we start to see how specialized cells are working to digest milk. The lining of the stomach, which is about 6mm in size, has specialized cells that start acting upon nutrients with enzymes. We can see from our size & orders of magnitude tool that the cells of the stomach are 1.0-1.6 um in size. Fats are broken down from big globules to smaller globules by gastric lipase. Proteins are broken down into amino acids by pepsin, which is an enzyme released from Chief cells in the stomach lining. The enzyme is much smaller than the cells at 5-10 nm in size. So, we can see that different structures of different sizes make up this complex system.

	glucose and galactose. Also, fats get broken down even more now into free fatty acids by the enzyme lipase. The broken-down nutrients in the small intestine then get absorbed into the bloodstream. The lining of the small intestine has epithelial cells that absorb these broken-down nutrients into the bloodstream. The only nutrients that move further into the large intestine are water and electrolytes, like sodium and potassium. If any of that is left over after the large intestine, it's removed from the body as waste.	 Then, nutrients from milk move into the athlete's small intestine. More chemical digestion happens as an enzyme called lactase breaks lactose down into glucose and galactose. Also, fats get broken down even more now into free fatty acids by the enzyme lipase. The broken-down nutrients in the small intestine then get absorbed into the bloodstream. The lining of the small intestine has epithelial cells that absorb these broken-down nutrients into the bloodstream.  The only nutrients that move further into the large intestine are water and electrolytes, like sodium and potassium. If any of that is left over	 Then, nutrients from milk move into the athlete's small intestine. More chemical digestion happens as an enzyme called lactase breaks lactose down into glucose and galactose. Also, fats get broken down even more now into free fatty acids by the enzyme lipase. The broken-down nutrients in the small intestine then get absorbed into the bloodstream. The lining of the small intestine has epithelial cells that absorb these broken-down nutrients into the bloodstream. We can see from our size & orders of magnitude tool that glucose molecules are 800 pm, such a smaller size compared to the size of an epithelial cell ~20 um thick. This shows that glucose could easily travel into the epithelial cells. 

		after the large intestine, it's removed from the body as waste.	The only nutrients that move further into the large intestine are water and electrolytes, like sodium and potassium. If any of that is left over after the large intestine, it's removed from the body as waste.
How to Achieve This Level	Student completes 0-2 out of 5 Look Fors	Student completes 3-4 out of 5 Look Fors	Student completes 5 out of 5 Look Fors

Module 1 Look Fors	**Prompts to Support Students in Improving on Look Fors**
Include multiple methods of communication, including models and evidence from the module (video plus graphics/diagrams, written report plus graphics/diagrams, or video with narration of a slideshow) (INFO-H5). ● You can use the class consensus model, data sets, and/or models from any other resources from the module.	Ask students to return to their resources from the unit and choose appropriate graphics, diagrams, data, or other visual resources.
Clearly communicate scientific information in a way that is appropriate for your chosen audience (INFO-H5).	Ask students to compare their presentation language to the scientific explanations they wrote in the module and reflect on how they modified the language to be appropriate to their chosen audience. What terms and ideas did they simplify? Which did they make more complex? What would their chosen audience prefer?
Describe how the hierarchical organization and function of body systems, organs, and cells contributes to the digestion of milk (LS1.A-H3).	How did you explain the way the different parts of the body work together? How organs, cells, and molecules are related?
Describe the scale relationships between the models you are showing using orders of magnitude (SPQ-H4).	How did you help your audience understand the relative scale relationships shown in the diagrams or other visual resources you used?
Describe how the function of multiple kinds of specialized cells contributes to the digestion of milk (LS1.A-H1).	Identify at least three different kinds of specialized cells from the module resources and incorporate those into your presentation.

Module 2 Task Rubric

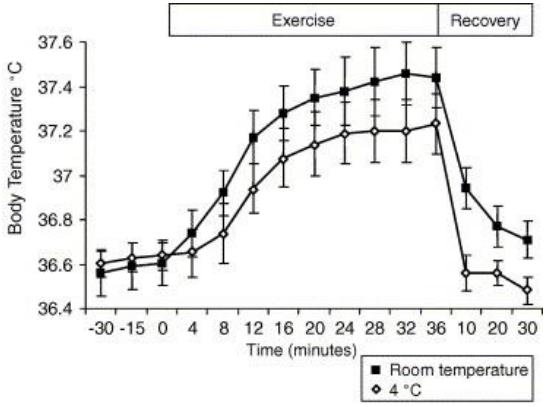
INFO-H5: Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

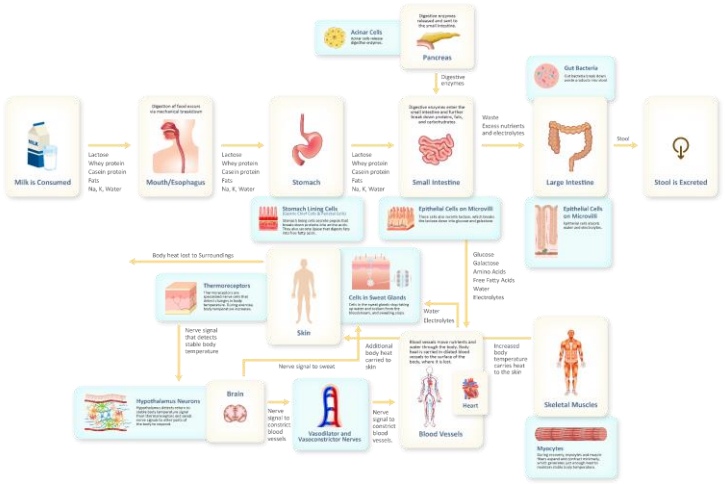
LS1.A-H1: Systems of specialized cells within organisms help them perform the essential functions of life.

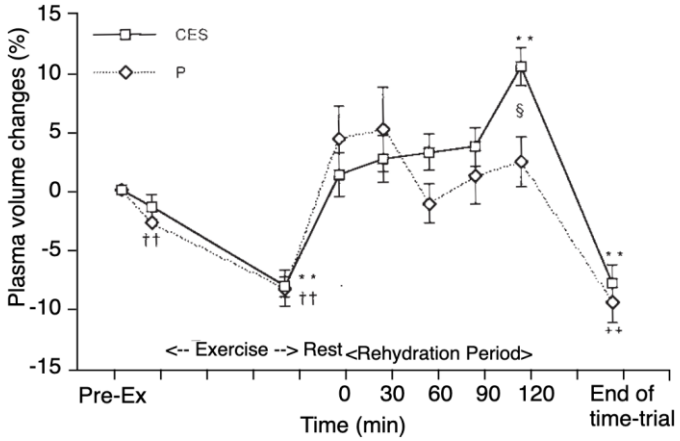
LS1.A-H4: Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and function even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (through negative feedback) what is going on inside the living system.

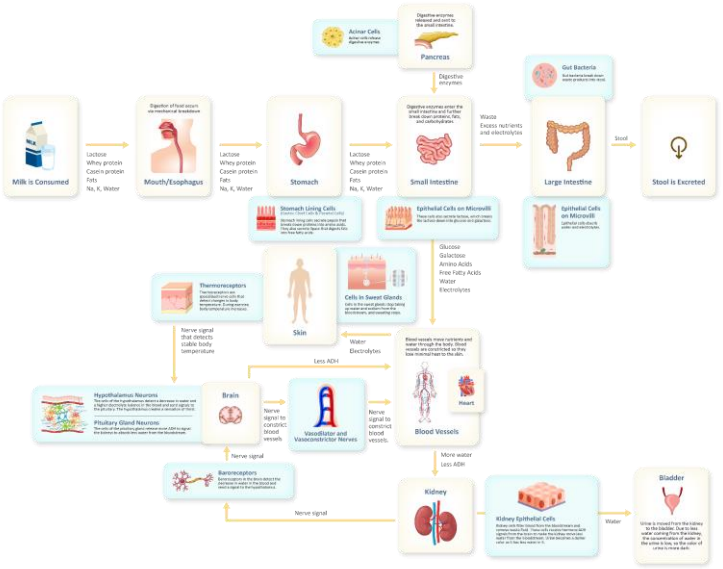
SC-H3: Feedback (negative or positive) can stabilize or destabilize a system.

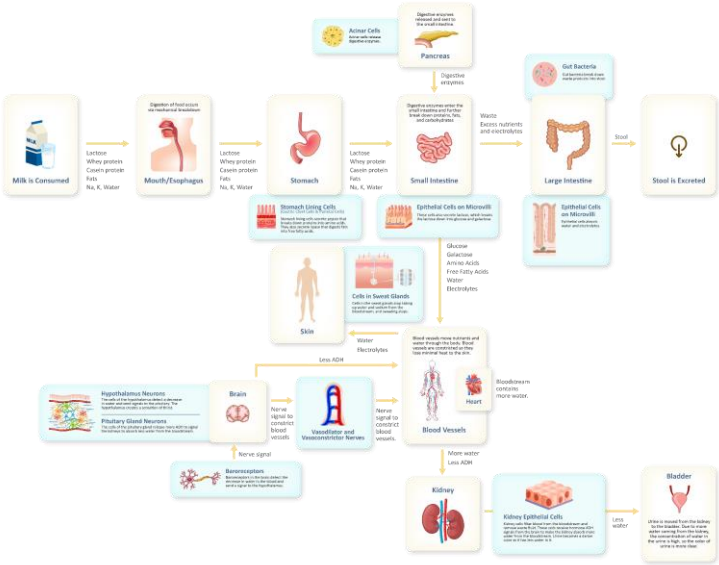
	Emerging	Developing	Proficient
Sample Student Response	Let's now look more closely at what's happening in the body during and after exercise. After a person works out, they typically get hot. The body gets hot due to exercise, and it has multiple ways in which it tries to cool down, like sweat or changing the blood vessels to	Let's now look more closely at what's happening in the body during and after exercise. After a person works out, they typically get hot. We looked at a study that was done to show how a person's internal body temperature changes during exercise. It shows that before exercise, the body temperature starts at a normal, stable state at about 36.5° C. When exercising, body temperature increases by about 0.5-1.0°C. Then, after exercise, body temperature returns to about 36.6°C.	Let's now look more closely at what's happening in the body during and after exercise. After a person works out, they typically get hot. Take a look at this study that was done to show how a person's internal body temperature changes during exercise.

	make more heat go out of the body. You get thirsty because you sweat and you pee out a lot of water. But, the body has ways of preventing it from losing too much water. It tries to save water by not putting too much in the urine or by sweating less. Milk can help your body recover from these effects because it has water in it, which replaces the water you lost.	The body gets hot due to exercise, and it has multiple ways in which it tries to cool down. First, thermoreceptors in the skin and muscles detect a change in temperature. They send a nerve signal to the hypothalamus in the brain, which then sends a signal via nerves to the sweat glands to produce sweat to cool the body. The hypothalamus also signals the vasodilation nerves to expand the blood vessels, allowing blood to bring heat from the body to the surroundings. This is one example of a feedback mechanism the body has to respond to the increase in temperature of the body to bring the temperature back to its stable state. Next, let's talk about why you get thirsty and why your urine color might change with exercise. The loss of water in sweat occurs because water moves from the bloodstream to the skin in sweat. The body has ways of preventing it from losing too much water, which is what happens when your blood volume decreases. Osmoreceptors detect the decrease in water in the blood and send a signal to the brain. The hypothalamus in the brain receives the signal from the osmoreceptors. This results in the sensation of thirst and increased production of ADH	 Before exercise, the body temperature starts at a normal, stable state at about 36.5°C. When exercising, body temperature increases by about 0.5-1.0°C. Then, after exercise, body temperature returns to about 36.6°C. The body gets hot due to exercise, and it has multiple ways in which it tries to cool down. I'll show you them on this model.

		from the pituitary gland in the brain. The pituitary region of the brain sends ADH to the kidney via the bloodstream to absorb less water from the blood, leading to less water moving to the bladder, where it is stored as urine. The urine color becomes darker. This process is also a negative feedback loop and is how the body prevents additional water loss. Now, these effects of exercise on the body might sound alarming, but they are all part of your body's natural response to try to maintain stable conditions. Milk can also help your body recover from these effects. In recovery, when someone stops exercising, they cool down. The temperature change is detected by thermoreceptors, which send a signal to the hypothalamus, which then signals the sweat glands to stop sweating. When someone drinks milk, the water in the milk moves through digestion into the bloodstream, which brings the amount of water in the blood back to its stable state. The osmoreceptors detect this change, cease the sensation of thirst, and send less ADH to the kidneys. The kidneys can now absorb more water from the bloodstream, passing it on to the bladder as urine. Urine is a lighter color as a result.	 Effects of Exercise Model Lesson 10 First, thermoreceptors in the skin and muscles detect a change in temperature. They send a nerve signal to the hypothalamus in the brain, which then sends a signal via nerves to the sweat glands to produce sweat to cool the body. The hypothalamus also signals the vasodilation nerves to expand the blood vessels, allowing blood to bring heat from the body to the surroundings. This is one example of a feedback mechanism the body has to respond to the increase in temperature of the body to bring the temperature back to its stable state. Next, let's talk about why you get thirsty and why your urine color might change in exercise. The loss of water in sweat occurs because water moves from the bloodstream to the skin in sweat. Take a

			look at this graph of blood volume changes over time in exercise.  We can see that blood volume decreased during two instances of exercise. First, during the moderate effort exercise, it decreased by about 10%. Then, during the max effort exercise, it decreased by 10-20%. The body has ways of preventing it from losing too much water, which is what happens when your blood volume decreases. Let's again look at this model to see how that happens.

			 Exercise Effects Model from Lesson 12 Osmoreceptors detect the decrease in water in the blood and send a signal to the brain. The hypothalamus in the brain receives the signal from the osmoreceptors. This results in the sensation of thirst and increased production of ADH from the pituitary gland in the brain. The pituitary region of the brain sends ADH to the kidney via the bloodstream to absorb less water from the blood, leading to less water moving to the bladder, where it is stored as urine. The urine color becomes darker. This process is also a negative feedback loop and is how the body prevents additional water loss.

			Now, these effects of exercise on the body might sound alarming, but they are all part of your body's natural response to try to maintain stable conditions. Milk can also help your body recover from these effects. Let me show you.  Recovery model from Lesson 12 In recovery, when someone stops exercising, they cool down. The temperature change is detected by thermoreceptors, which send a signal to the hypothalamus, which then signals the sweat glands to stop sweating. When someone drinks milk, the water in the milk moves through digestion into the bloodstream, which brings the amount of water in the blood back to its stable state. The osmoreceptors detect this change, cease the

			sensation of thirst, and send less ADH to the kidneys. The kidneys can now absorb more water from the bloodstream, passing it on to the bladder as urine. Urine is a lighter color as a result.
How to Achieve This Level	Student completes 0-1 out of 4 Look Fors	Student completes 2-3 out of 4 Look Fors	Student completes 4 out of 4 Look Fors

Module 2 Look Fors	**Prompts to Support Students in Improving on Look Fors**
Include multiple methods of communication, including models and evidence from the module (video plus graphics/diagrams, written report plus graphics/diagrams, or video with narration of a slideshow). ● You can use the class consensus model, data sets, and/or models from any other resources from the module (INFO-H5).	Ask students to return to their resources from the unit and choose appropriate graphics, diagrams, data, or other visual resources.
Clearly communicate scientific information in a way that is appropriate for your chosen audience (INFO-H5).	Ask students to compare their presentation language to the scientific explanations they wrote in the module and reflect on how they modified the language to be appropriate to their chosen audience. What terms and ideas did they simplify? Which did they make more complex? What would their chosen audience prefer?
Describe how exercise can destabilize water balance in the body and how negative feedback mechanisms in the body and the consumption of milk can help the body return water balance to its stable state (LS1.A-H4, SC-H3).	How did you describe the feedback mechanisms associated with water levels? With temperature? How did you describe how water in milk can help the body during exercise recovery?
Describe how the functions of multiple kinds of specialized cells contribute to maintaining and adjusting water levels in the body in response to changes in the body's conditions (LS1.A-H1).	Identify at least three different kinds of specialized cells from the module resources and incorporate those into your presentation.

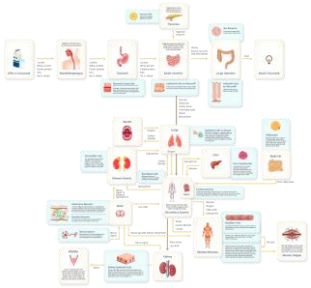
Module 3 Task Rubric

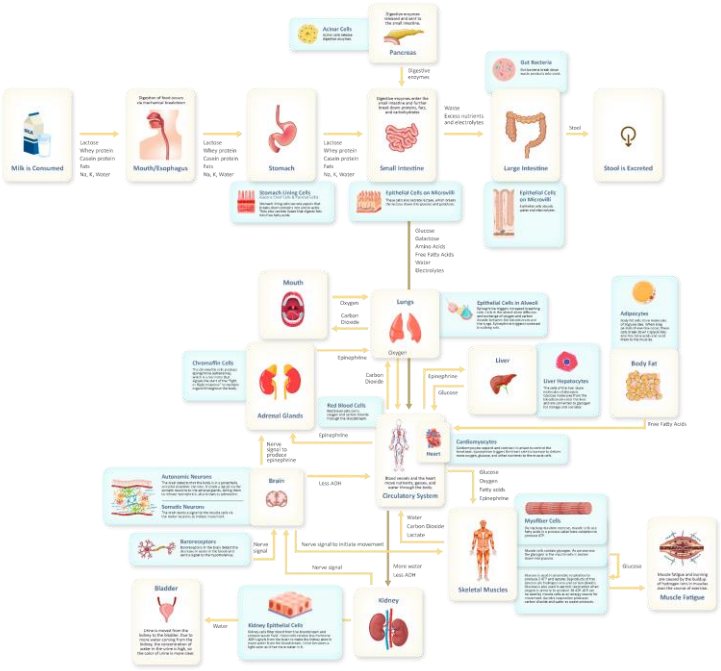
INFO-H5: Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

LS1.A-H1: Systems of specialized cells within organisms help them perform the essential functions of life.

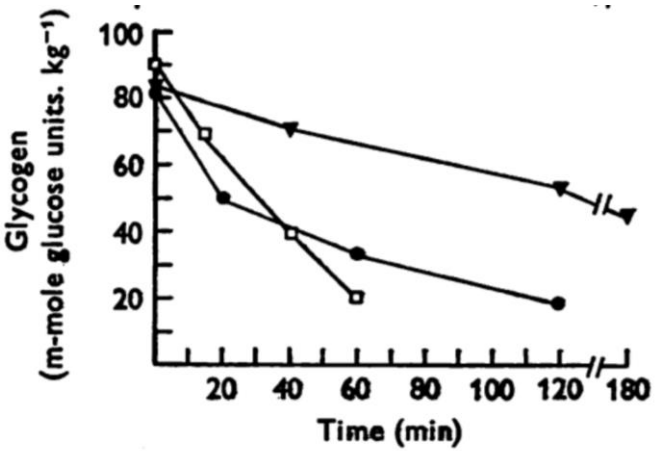
LS2.B-H1: Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.

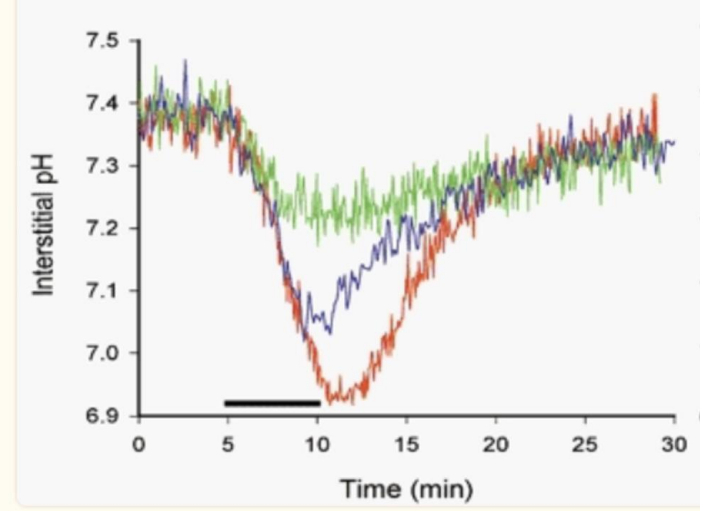
SC-H1: Much of science deals with constructing explanations of how things change and how they remain stable.

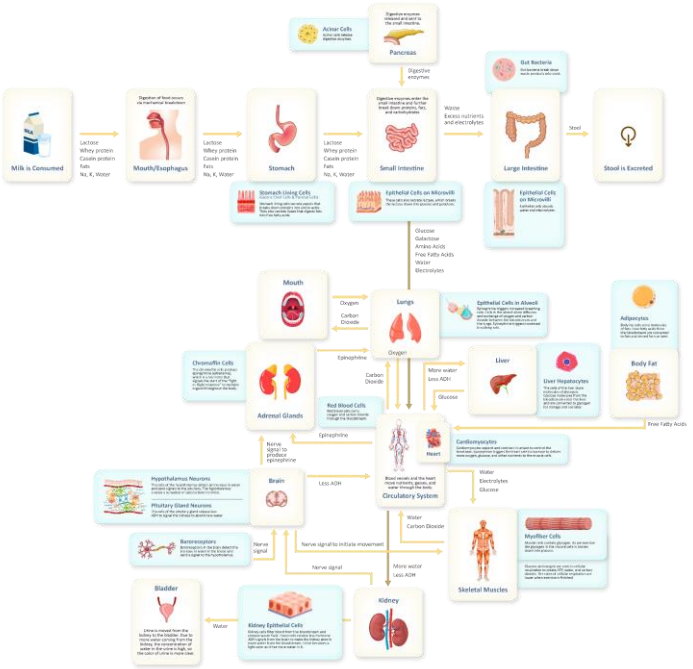
	Emerging	Developing	Proficient
Sample Student Response	 You can see in the exercise effects model that when we exercise, our body uses glucose to make energy. To make energy, the cells use oxygen and	Now, let's talk about why you get fatigued during exercise and how milk can help you recover. Intense exercise requires a lot of energy to keep your muscles moving. Our muscles make energy using cellular respiration to make ATP. At the beginning of intense exercise, our muscle cells can break down their glycogen stores into glucose molecules that can be used for anaerobic respiration. Most of the energy generated at the beginning of an intense workout is anaerobic because that doesn't require waiting for extra oxygen to be delivered into the bloodstream.	Now let's talk about why you get fatigued during exercise and what you can do to help recover from that fatigue and keep going. One thing to know going into this is that when scientists study how the body responds to exercise, they typically do so by describing the changes that happen to a lot of different molecules in the body. So we'll be discussing a lot of molecular details in this part of the presentation. Exercise requires a lot of energy! Your body transforms stored molecules or molecules in the food you eat into cellular energy. Let me show you how this works on this model.

	glucose. The oxygen comes from the lungs. After exercise, the glucose from milk replaces the glucose our body uses so that we have the energy to work out again.	While anaerobic respiration is happening, we are also breathing faster and our heart is beating faster. Oxygen is breathed into the lungs and enters the bloodstream through the alveoli sacs. Carbon dioxide from the muscle cells making ATP is moving in the opposite direction to exit the bloodstream, enter the lungs, and be breathed out of the body. As enough oxygen gets to the muscle cells, they can use oxygen to generate energy using aerobic cellular respiration. To keep blood glucose levels steady, the liver breaks down its glycogen stores and releases the glucose molecules into the bloodstream. After intense exercise, our bodies need to replace the glucose molecules that were used. As milk is digested, lactose is broken down into glucose and galactose molecules. The glucose molecules can be absorbed into the bloodstream, where they can refill the glycogen stores inside the liver and the skeletal muscles.	 To make energy to power your muscles to move rapidly during exercise, muscle cells need glucose. Glucose is used in the process of anaerobic respiration early in intense exercise. This process occurs without oxygen present and produces 2 ATP, which is the cellular energy your muscles use for movement. When exercise continues, oxygen moves in from your lungs, through the epithelial cells, into your bloodstream, and finally to the muscles, where the myocytes take to use in aerobic respiration. This process uses glucose to produce 38 ATP to power the muscle cells for rapid movement during exercise.

			Muscle cells get this glucose from a couple of different places. First, they can get it from the bloodstream, but that glucose runs out very quickly. Next, they can get it from glycogen or a form of stored glucose. As you can see in the model, when the body needs to make energy quickly to power your exercise, the brain sends a signal along the autonomic neurons to the chromaffin cells in the adrenal glands to produce epinephrine and pass it to the bloodstream. There, it moves to the hepatocytes in the liver and to the myocytes in the muscles to tell these organs to start breaking down their glycogen into glucose, which can be used by the muscles in anaerobic and aerobic respiration to generate more energy. The figure below from Gollnick, Piehl, and Saltin demonstrates that muscle glycogen stores in the myocytes decrease rapidly with intense exercise (open square line), meaning that glycogen is being broken down into glucose, which is used in the myocytes to produce ATP.

			 Now, as you keep exercising, you start to get fatigued, and your muscles start to feel like they are burning. This burning and fatigue comes from the change in pH of the muscles during exercise. Below is a graph of the Interstitial pH in human skeletal muscle during and after dynamic-graded exercise by Street, Bangsbo, and Juel. Each color was a different intensity of workout. Red was the most intense. You can see pH in the interstitial space of the muscle dropped, especially during high-intensity exercise.

			 When the pH of the muscles drops, the brain receives an alert of pain/burning from the skeletal muscle as a way of telling you to slow down! When you stop and rest, the pH of the muscle returns to its normal level so you can keep going. Now, let's say an athlete was doing very long endurance workouts. They would not be able to maintain the high intensity, but their bodies could keep exercising for a very long time because the body can modify fatty acids to use as a fuel source for a process called beta-oxidation in the myocytes. This is a process the body uses to create ATP from fats.

			What can you do to help your body have enough energy to keep going? Well, let me show you this model.  Drinking milk after an intense workout helps the body restore its fuel sources. After the nutrients in milk is digested and absorbed, glucose arrives in the bloodstream. There it can enter the liver hepatocytes and the muscle myocytes, which allows the liver and muscle glycogen stores to be replenished. This way, an athlete has a supply of glycogen that is available for their next intense workout to be made into ATP.

How to Achieve This Level	Student completes 0-2 out of 5 Look Fors	Student completes 3-4 out of 5 Look Fors	Student completes 5 out of 5 Look Fors

Module 3 Look Fors	**Prompts to Support Students in Improving on Look Fors**
Include multiple methods of communication, including models and evidence from the module (video plus graphics/diagrams, written report plus graphics/diagrams, or video with narration of a slideshow) (INFO-H5) ● You can use the class consensus model, data sets, and/or models from any other resources from the module.	What specific evidence from the module did you choose to include in your presentation?
Clearly communicate scientific information in a way that is appropriate for your chosen audience (INFO-H5).	Ask students to compare their presentation language to the scientific explanations they wrote in the module and reflect on how they modified the language to be appropriate to their chosen audience. What terms and ideas did they simplify? Which did they make more complex? What would their chosen audience prefer?
Describe how the energy for exercise comes from aerobic and anaerobic respiration and how this energy is expended during exercise and recovered with milk (LS2.B-H1).	How did you describe where people get the cellular energy that is used in exercise? How is that cellular energy replenished with milk?
Describe how the function of multiple kinds of specialized cells contributes to the processes of cellular respiration and anaerobic respiration (LS1.A-H1).	Identify at least three different kinds of specialized cells from the module resources and incorporate those into your presentation.
Describe how much of the study of exercise and recovery involves tracking how various molecular factors in the body change or remain stable (SC-H1).	In what ways did you include a reflection on stability and change in your response?

Part 2/Module 4 Task Rubric

INFO-H5: Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

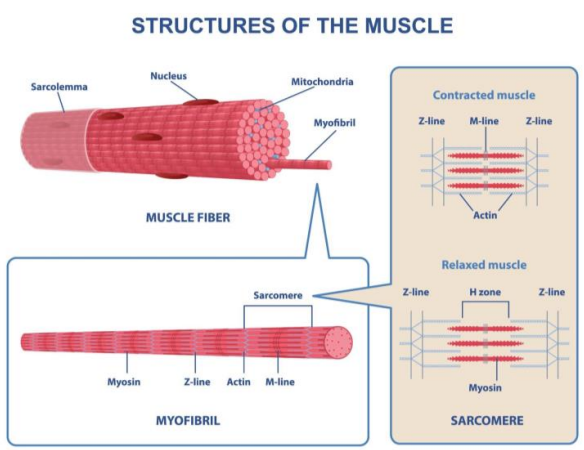
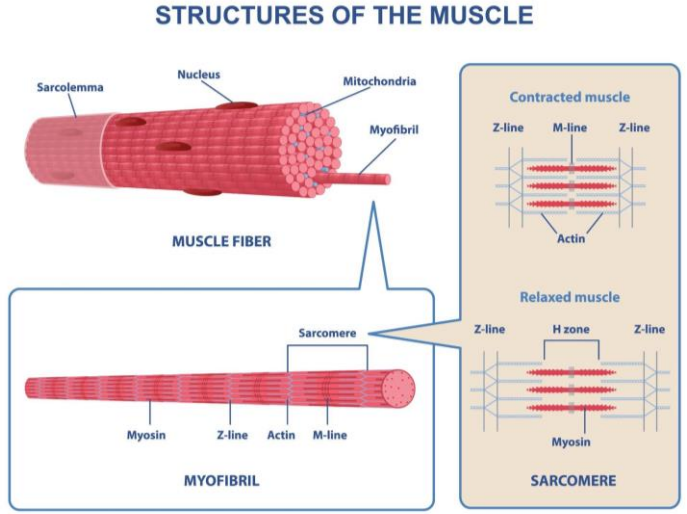
LS1.A-H1: Systems of specialized cells within organisms help them perform the essential functions of life.

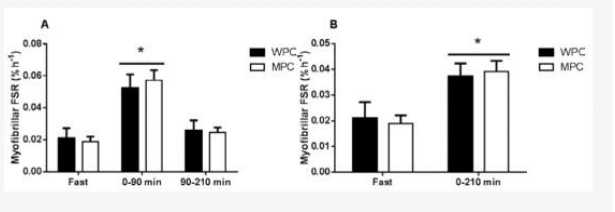
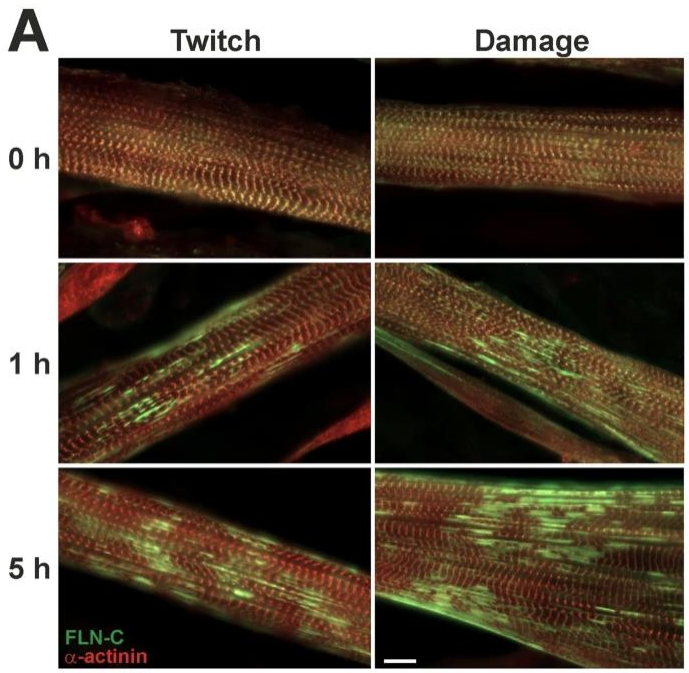
LS1.A-H4: Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and function even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (through negative feedback) what is going on inside the living system.

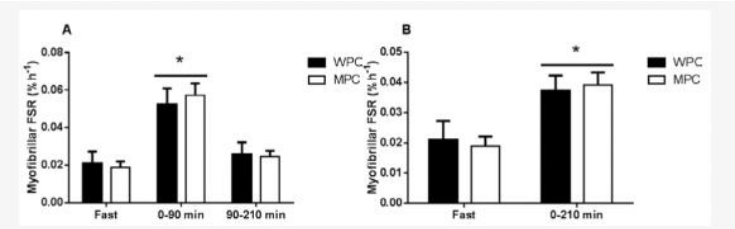
SC-H1: Much of science deals with constructing explanations of how things change and how they remain stable.

SC-H3: Feedback (negative or positive) can stabilize or destabilize a system.

	Emerging	Developing	Proficient
Sample Student Response	So, why do athletes have sore muscles after they work out, and how do the muscles repair themselves? Muscles are composed of cell structures called myofibers. When a muscle contracts, its myofibers slide past each other in a coordinated manner; conversely, when the muscle relaxes, these myofibers slide past	So, why do athletes have sore muscles after they work out, and how do the muscles repair themselves? First, you probably need to understand that the muscles are composed of cell structures called myofibers. Take a look at the myofibers on the diagram below.	So, why do athletes have sore muscles after they work out, and how do the muscles repair themselves? First, you probably need to understand that the muscles are composed of cell structures called myofibers. Take a look at the myofibers on the diagram below.

	each other in the opposite direction. So you're probably thinking, how exactly do tears get repaired? After exercise, the body responds to exercise-induced damage to muscle fibers by increasing a process called protein synthesis in the muscle cells. This process of protein synthesis is also how milk helps you recover from soreness. The microtears damage the muscle fibers, and the muscle fibers undergo protein synthesis to be repaired. Proteins in milk are broken down into amino acids, and they enter the	 The structure of the myofibers and the filaments within the myofiber help the muscle fiber function. For example, when a muscle contracts, its myofibers slide past each other in a coordinated manner; conversely, when the muscle relaxes, these myofibers slide past each other in the opposite direction. So you're probably thinking, how exactly do these tears get repaired? After exercise, the body responds to exercise-induced damage to muscle fibers by increasing a process called protein synthesis in the muscle cells. You can see this graph from Lesson 27 shows protein synthesis happening. The studies showed that drinking protein	 The molecular structure of the myofibers and the filaments within the myofiber help the muscle fiber function. For example, when a muscle contracts, its myofibers slide past each other in a coordinated manner; conversely, when the muscle relaxes, these myofibers slide past each other in the opposite direction. When muscles contract and relax during exercise, they undergo tiny microtears in their structure. These microtears are responsible for the feeling of muscle soreness. Take a look at this data from Lesson 26, that shows microtears in the

	bloodstream where they are transported to the myocytes. Now this is the important part for you to know, when muscles recover from exercise, they also become larger and stronger in the process. So basically, to wrap it up and make it all connect, as athletes move, their muscles contract and get little tears. These micro-tears cause muscles to feel sore. The other important part is the proteins! The proteins in milk break down into amino acids, which are crucial for repairing skeletal muscle microtears to	drinks (at least for healthy people) increases the rate of protein synthesis above rest.  This process of protein synthesis is also how milk helps you recover from soreness. The microtears damage the muscle fibers, and the muscle fibers undergo protein synthesis to be repaired. Proteins in milk are broken down into amino acids, and they enter the bloodstream where they are transported to the myocytes. The myocytes use these amino acids in protein synthesis to make new muscle fibers and recover from the damage they had. The body also increases the amount of a type of cell called a satellite cell at the site of the muscle fiber injury. This is part of stabilizing the muscle structure. Now this is the important part for you to know, when muscles recover from exercise, they also become larger and stronger in the process. This happens through the release	muscle. Figure 1  So you're probably thinking, how exactly do these tears get repaired? After exercise, the body responds to exercise-induced damage to muscle fibers by increasing a process called protein synthesis in the muscle cells. You can see this graph from Lesson 27 shows protein synthesis happening. The studies showed that drinking protein drinks (at least for healthy people) increases the rate of protein synthesis above rest. They both showed that protein synthesis remains increased for at least 210 minutes in one and 28 hours in the other.

	aid in exercise recovery.	of several molecules called growth factors that send growth signals to the muscle cells. The process of the body increasing its strength in response to exercise is known as adaptation because the body adapts to the stress placed on it. So basically, to wrap it up and make it all connect, as athletes move, their muscles contract and experience microtears. These microtears cause muscles to feel sore and we know that specialized cells, called satellite cells, go in and repair microtears. The other important part is the proteins! The proteins in milk break down into amino acids, which are crucial for repairing skeletal muscle microtears to aid in exercise recovery.	 This process of protein synthesis is also how milk helps you recover from soreness. The microtears damage the muscle fibers, and the muscle fibers undergo protein synthesis to be repaired. Proteins in milk are broken down into amino acids during digestion, and they enter the bloodstream where they are transported to the myocytes. The myocytes use these amino acids in protein synthesis to make new muscle fibers and recover from the damage they had. The body also increases the amount of a type of cell called a satellite cell at the site of the muscle fiber injury. This is part of stabilizing the muscle structure which will help the body recover from the damage done to the muscle cells. So the body has several negative feedback responses to help it recover from the microtears in muscle fibers that happen during exercise. Basically, Immune cells move to the site of the muscle microtears and Immune cells help clear away

			damaged cells and reconstruct new muscle fiber cells. Satellite cells in the muscle fibers are also activated; these cells undergo cell division to differentiate into new muscle fiber cells. Finally, the muscle cells themselves increase their rate of protein synthesis, which helps rebuild proteins in the muscle fiber cells. All of these responses help the myocytes regain a state of stability after they are damaged. Now this is the important part for you to know, when muscles recover from exercise, they also become larger and stronger in the process. This happens through the release of several molecules called growth factors that send growth signals to the muscle cells. The process of the body increasing its strength in response to exercise is known as adaptation because the body adapts to the stress placed on it. The body also has several additional adaptations to exercise, such as increased lung capacity, cardiac output, and capillary density. So basically, to wrap it up and make it all connect, as athletes move, their muscles contract and experience microtears. These microtears cause muscles to feel sore and we know that specialized cells, called satellite cells, go in and repair microtears. The other important part is the proteins! The proteins in milk break down into amino acids, which

			are crucial for repairing skeletal muscle microtears to aid in exercise recovery.
How to Achieve This Level	Student completes 0-2 out of 5 Look-Fors	Student completes 3-4 out of 5 Look-Fors	Student completes 5 out of 5 Look-Fors

Module 4 Look-Fors	**Prompts to Support Students in Improving on Look Fors**
Include multiple methods of communication, including models and evidence from the module (video plus graphics/diagrams, written report plus graphics/diagrams, or video with narration of a slideshow) (INFO-H5). ● You can use the class consensus model, data sets, and/or models from any other resources from the module.	What specific evidence from the module did you choose to include in your presentation?
Clearly communicate scientific information in a way that is appropriate for your chosen audience (INFO-H5).	In your response, highlight direct scientific information you used from the module that includes informal language. Use a different color to highlight formal language.
Describe how exercise can destabilize muscle structure and function in the body and how negative feedback mechanisms in the body and the consumption of milk can help the body return muscle structure and function to its stable state (LS1.A-H4, SC-H3).	How did you describe the feedback mechanisms associated with muscle structure and function? How did you describe how the presence or lack of milk nutrients can help the body during exercise recovery?
Describe how the functions of multiple kinds of specialized cells contribute to muscle structure and function and to exercise recovery (LS1.A-H1).	Identify at least three different kinds of specialized cells from the module resources and incorporate those into your presentation.
Describe how much of the study of the human body involves tracking how various molecular factors in the body change or remain stable (SC-H1).	In what ways did you include a reflection on stability and change in your response?