Common Student Ideas about Food Chains and Food Webs

	Common Student Idea(s)	Scientific Explanation
Definition of Food	1. Food is the stuff that organisms eat, chew, or take into their bodies.	Food is energy-supplying matter that organisms can use as a source of energy to fuel life processes such as growth and reproduction. The matter in food also supports growth. It provides the "stuff" that new cells and molecules are made of.
	2. Anything useful taken into an organism's body is food, including water, air, and minerals.	Not everything taken into an organism is energy-supplying food. Water, vitamins, minerals, oxygen, and carbon dioxide are not considered food for living things because they don't provide energy that living things can use. Water and carbon dioxide provide *matter* that producers use to make food molecules (glucose) during photosynthesis. But by themselves, they don't provide energy that living things can use to live and grow. Mineral nutrients from the soil (such as nitrogen and phosphorus) and vitamins also don't provide energy for living things. The products labeled "plant food" in stores are actually just minerals, not energy-supplying food. These minerals are used to change the simple glucose molecules made during photosynthesis into more complicated molecules needed for plant health (e.g., proteins).
	3. Food is needed for living things to be healthy, to live, and to grow. *[Students don't consider specific functions of food in organisms.]*	Food supplies the *energy* that each cell of an organism needs for internal life processes, such as chemical reactions in their cells, transportation of matter, reproduction, and maintenance of a stable internal environment (homeostasis). Living things need *matter* from food to build new cells and molecules and to add mass (to grow).

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Producers	4. Plants don't need food; they just need water. The plants that people take care of need food, but plants in the forest don't.	All organisms, whether plant or animal, need food to provide both the matter and energy that they need to support life processes (moving, responding to stimuli, growing, breathing, reproducing).
	5. Like us, plants have multiple sources of food.	The *only* source of energy-supplying food for plants is the food they produce internally using energy from the Sun, matter from the air (carbon dioxide), and water.
	6. Sunlight is food for plants.	Sunlight is a form of energy that doesn't provide any of the matter organisms need to grow (get bigger). So sunlight by itself is not food for plants.
	7. Plants get their food from soil or from plant food that is added to soil.	The matter that plants take from the soil (such as nitrogen and phosphorus) is not food because it doesn't provide energy that living things need to support life. In addition, soil nutrients are *not* used to make food (glucose) during photosynthesis. Soil nutrients help plants grow better because they are used to build materials plants need. For example, nitrogen is used to build protein molecules that plants can use to regulate life processes (e.g., enzymes, hormones). The everyday reference to fertilizers as plant food promotes the inaccurate idea that plants get food from soil.
	8. Plants make food for people and animals to eat.	Plants don't make food with any intent to help others! They need the food they make to keep themselves alive and healthy. Plants use some of the food they make for energy to live. In a chemical reaction with oxygen, food molecules are rearranged and energy is released to support a plant's life processes. This process is called *cellular respiration*. Plants store some of the food they make in seeds, roots, and fruit.
Consumers	9. Big animals are carnivores, and small animals are herbivores.	The size of an animal does not determine what it eats. Elephants and blue whales, for example, are very large but get their food from plants; they are herbivores.

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Consumers	10. Carnivores don't need plants.	Carnivores—animals that only eat other animals—don't directly need plants; however, they do need them indirectly to harness the energy from sunlight and use it to transform water and carbon dioxide into energy-supplying food. Without this food energy, herbivores (plant-eating animals) would die. If this happened, the carnivores would lose their food source and die too.
Decomposers	11. Things rot by themselves; it's a feature of aging and death. *[Students don't see a need for a causal explanation.]*	For decomposition to occur, other organisms (decomposers) must be present. If you could put once-living matter in a sealed container that was free of any living organisms, rotting wouldn't occur. **The causal explanation:** When plants and animals die or leave waste products behind, decomposers break down this matter. Decomposers, which include various fungi, bacteria, protists, and even some animals, chemically break down dead organisms. They use chemical compounds to consume these organisms and convert them to simpler substances. In this breakdown, energy is released that decomposers use to live, and new by-product molecules are released into the air (such as carbon dioxide and water) or left in the soil (such as water and the minerals nitrogen and phosphorus).
	12. Decomposers are organisms that can be seen with the naked eye. *[Students don't consider organisms they can't see, such as bacteria, as decomposers.]*	Microorganisms, such as bacteria and mold, play the major role of chemical breakdown in decomposition. They use chemical compounds to consume deceased organisms and convert them to simpler substances. Larger animals we can see with the naked eye (vultures, worms, woodlice, slugs, and dung flies) play a support role in the decomposition process. These *detritivores* eat (scavenge) larger pieces of dead organisms, exposing more of these organisms for fungi and bacteria, the major decomposers, to chemically decompose.
	13. The only role of decomposers is to recycle matter. *[Students tend to think of decomposers (like bacteria and mold) only as organisms that recycle matter, not as organisms that consume food to get the energy and matter they need to live and grow.]*	Decomposers obtain and use energy and matter from their food (waste products and dead organisms) to live, grow, and reproduce. They need food just as all other living organisms do.

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Decomposers	14. During decomposition, dead things fall down in the dirt and get broken down by the action of wind and rain. During decomposition, dead things dry out. For example, water leaks out of the leaves. During decomposition, dead things melt.	All of these explanations of decomposition focus on physical changes in once-living matter. While physical changes are involved in the breakdown of once-living matter (e.g., detritivores like vultures physically break down an organism into smaller pieces), the decomposition process depends on chemical reactions in which molecules are rearranged to create new molecules (e.g., carbon dioxide and water). Students who think that dead things melt are noticing that some rotting matter gets "juicy," and they interpret the process as melting rather than a chemical change in which water is a by-product.
	15. During decomposition, dead things shrink and disappear.	While dead organisms do shrink as they decompose, the total amount of matter in the system remains the same. Much of the matter that was in the dead organism is transformed into carbon dioxide. If we compare a closed container before and after decomposition, the container will have the same mass.
Food Chains and Food Webs	16. Food chains are about predators and prey ("what eats what"), not about tracing the flow of energy.	Categorizing organisms as producers and consumers allows for a deeper understanding of the energy flow and matter cycling in an ecosystem.
	17. Food webs and food chains are the same thing.	Food chains and food webs are both representations of food relationships among organisms. However, food chains are linear. They portray food relationships in a simplistic way. Food webs, in contrast, better represent nature by showing the complex integration of many food chains and the interdependencies of many species.
	18. Animals don't need plants.	All organisms in a food chain or food web are dependent on plants to harness energy from the Sun and use it to make energy-supplying food molecules. Without plants, there would be no source of food matter and energy for herbivores. Without food matter and energy, herbivores would die, and the animals that get their food matter and energy from the herbivores would also die.

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Food Chains and Food Webs	19. Plants don't need animals.	Plants are more self-sufficient than animals because they can make their own energy-supplying food as long as they have a supply of sunlight, carbon dioxide, and water. In fact, plants existed on Earth for a long time without the presence of animals. While plants are largely self-sufficient, they do benefit from having animals in their environment. For example, decomposers ensure that matter (carbon dioxide, water, minerals) is recycled in the plants' environment.
	20. Varying the population size of one organism will only affect the others that are directly connected to it in a food web.	Food webs show the interconnectedness of all organisms in an ecosystem. A change in any population in an ecosystem affects the ecosystem as a whole, since it changes the amount and kind of energy and matter that are available for living things to use.
Matter	21. Living and nonliving things "have" or contain matter. There is matter in a book.	Living and nonliving things are entirely made of matter. Every part of a plant or a book is matter.
	22. Decomposers create matter.	Decomposers don't create matter. They take larger chunks of matter (waste products, dead plants and animals) and break them down into very small pieces. These small pieces are usually molecules like carbon dioxide, water, nitrates, or other compounds that plants can use.
	23. Matter and energy are the same thing.	Matter and energy are different. Matter is physical "stuff" that takes up space and has mass. Energy, in contrast, does not take up space or have mass. It's really hard to comprehend that energy is clearly evident in our world—making all kinds of things happen—but it isn't a "thing" that has mass.

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Matter	24. Matter can turn into energy, and energy can turn into matter.	Matter cannot change into energy, and energy cannot change into matter. But during photosynthesis, matter is rearranged to form new kinds of matter (e.g., carbon dioxide and water molecules are changed into glucose molecules). And light energy from the Sun is transformed into stored chemical energy in glucose molecules. Thus, matter can be rearranged, and energy can change form. But matter cannot change into energy, and energy cannot change into matter.
Energy	25. Energy can be recycled in a food chain or food web. The expression "Energy gets used up" means that energy disappears.	Energy cannot be recycled in food webs. Energy changes forms as it moves among organisms and in the environment. As it moves through a food web, food energy is released and used by living things to support life activities. During this process, much energy is changed to heat energy that is released into the environment and spreads through the universe. This heat becomes so spread out that it isn't useful. The energy hasn't disappeared, but it cannot be used again by living things. This makes it appear to students that the energy has been destroyed or used up.
	26. Decomposers release some energy back to plants.	Decomposers don't recycle energy. They break matter into small pieces that plants can use. These small pieces don't contain any usable energy, only matter that plants need for some of their life processes.
	27. All energy consumed by one organism is passed on to the next organism in the food chain.	If you take an average across whole populations of organisms, only about 10% of the energy in one trophic level (producers, primary consumers, and secondary consumers) is passed on to the next trophic level.
	28. Carnivores have the most energy because they are at the end of the food chain or food web.	Energy is distributed throughout an ecosystem. Looking at the whole ecosystem, most of the energy is present in the producers. This is due to the large numbers of producers present in ecosystems. Less energy is available for consumers, so there are fewer consumers. This is true only if you look at whole populations. It doesn't apply to individual animals or plants.