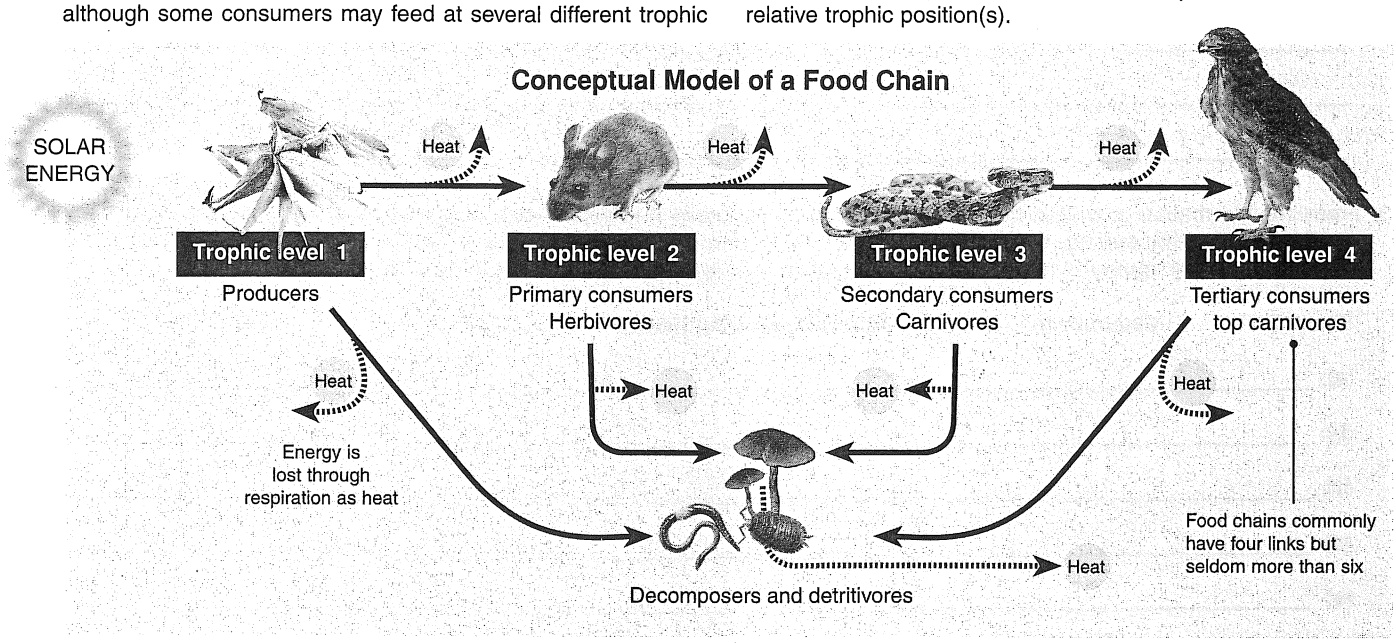
Food Chains and Webs

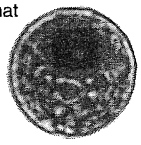
Every ecosystem has a **trophic structure**: a hierarchy of feeding relationships which determines the pathways for energy flow and nutrient cycling. Species are assigned to trophic levels on the basis of their sources of nutrition, with the first trophic level (the **producers**), ultimately supporting all other (consumer) levels. Consumers are ranked according to the trophic level they occupy, although some consumers may feed at several different trophic levels. The sequence of organisms, each of which is a source of food for the next, is called a **food chain**. The different food chains in an ecosystem are interconnected to form a complex web of feeding interactions called a **food web**. In the example of a lake ecosystem below, your task is assemble the organisms into a food web in a way that illustrates their trophic status and their relative trophic position(s).

Conceptual Model of a Food Chain

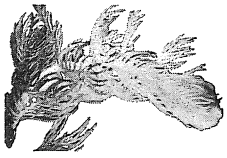


Components of a Simple Lake Ecosystem

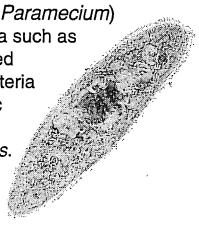
Autotrophic protists
e.g. Chlamydomonas One of the genera that form the phytoplankton (or algae).



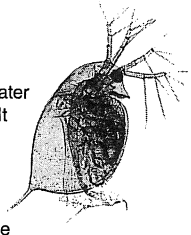
Macrophytes
A variety of species of macroscopic water plants adapted for being submerged, free-floating, or growing at the lake margin.



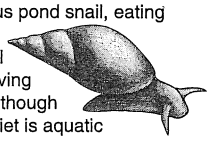
Protozan (*e.g. Paramecium*)
Ciliated protozoa such as *Paramecium* feed primarily on bacteria and microscopic algae such as *Chlamydomonas*.



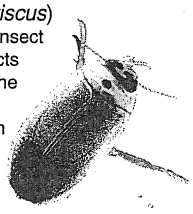
Daphnia
Small freshwater crustacean. It feeds on planktonic algae by filtering them from the water with its limbs.



Great pond snail (*Limnaea*)
Omnivorous pond snail, eating both plant and animal material, living or dead, although the main diet is aquatic macrophytes.

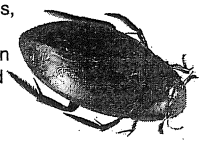


Diving beetle (*Dytiscus*)
Predators of aquatic insect larvae and adult insects blown into the lake. The will also eat organic detritus collected from the bottom mud.

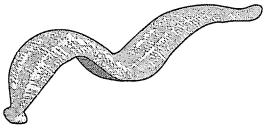


Asplanchna
A large, carnivorous **rotifer** that feeds on protozoa and young zooplankton (e.g. *Daphnia*). Note that most rotifers are small herbivores.

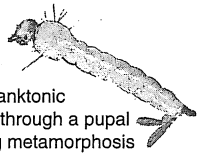
Herbivorous water beetles
(*e.g. Hydrophilus*)
Feed on water plants, although the young beetle larvae are carnivorous, feeding primarily on small pond snails.



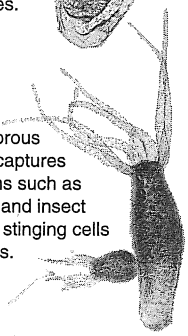
Leech (*Glossiphonia*)
Fluid feeding predator of smaller invertebrates, including rotifers, small pond snails, and worms.



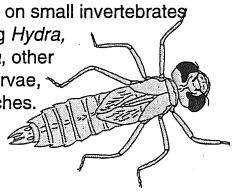
Mosquito larva
The larvae of most mosquito species, e.g. *Culex*, feed on planktonic algae before passing through a pupal stage and undergoing metamorphosis into adult mosquitoes.



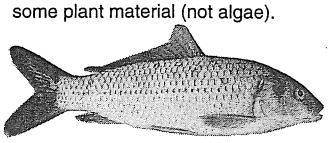
Hydra
A small carnivorous cnidarian that captures small prey items such as small *Daphnia* and insect arvae using its stinging cells on the tentacles.



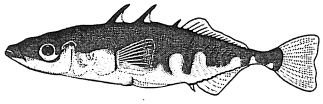
Dragonfly larva
Large aquatic insect larvae that are feed on small invertebrates including *Hydra, Daphnia*, other insect larvae, and leeches.



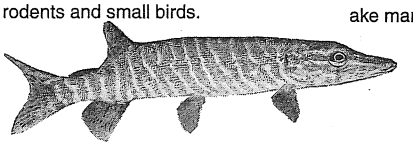
Carp (*Cyprinus*)
A heavy bodied freshwater fish that feeds mainly on bottom living insect larvae and snails, but will also take some plant material (not algae).



Three-spined stickleback (*Gasterosteus*)
A common fish of freshwater ponds and lakes. It feeds mainly on small invertebrates such as *Daphnia* and insect larvae.



Pike (*Esox lucius*)
A top ambush predator of all smaller fish and amphibians, although they are also opportunistic predators of rodents and small birds.



Detritus
Decaying organic matter from within the lake itself or it may be washed in from the ake margins.

1. (a) Describe what happens to the **amount** of energy available to each successive trophic level in a food chain:

_____

(b) Explain why this is the case: _____

_____

2. Describe the trophic structure of ecosystems, including reference to **food chains** and **trophic** levels:

_____

_____

_____

3. From the information provided for the lake food web components on the previous page, construct **five** different **food chains** to show the feeding relationships between the organisms. Some food chains may be shorter than others and some species will appear in more than one food chain. An example has been completed for you.

Example 1: Macrophyte ⟶ Herbivorous water beetle ⟶ Carp ⟶ Pike

(a) _____

(b) _____

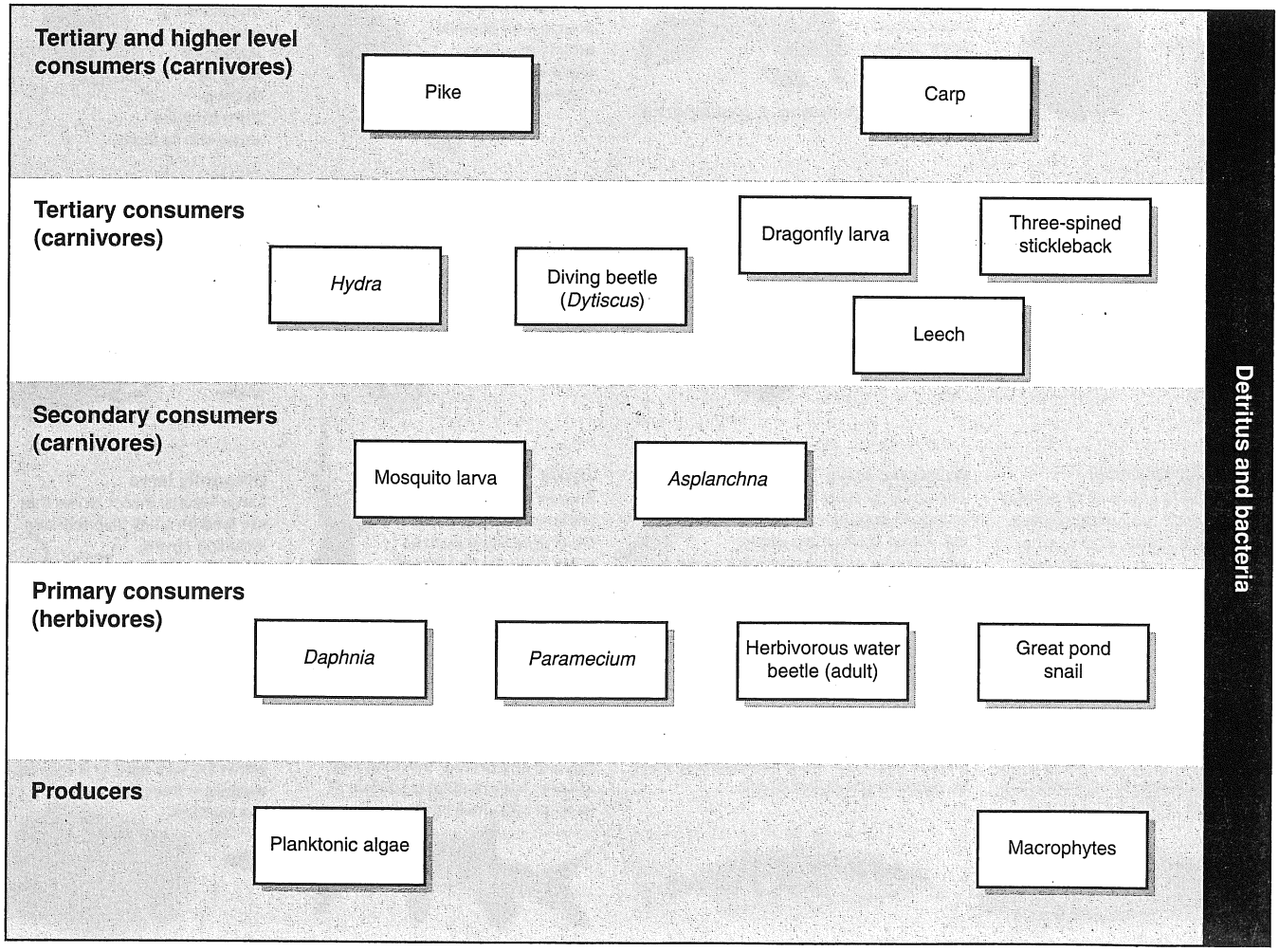
(c) _____

(d) _____

(e) _____

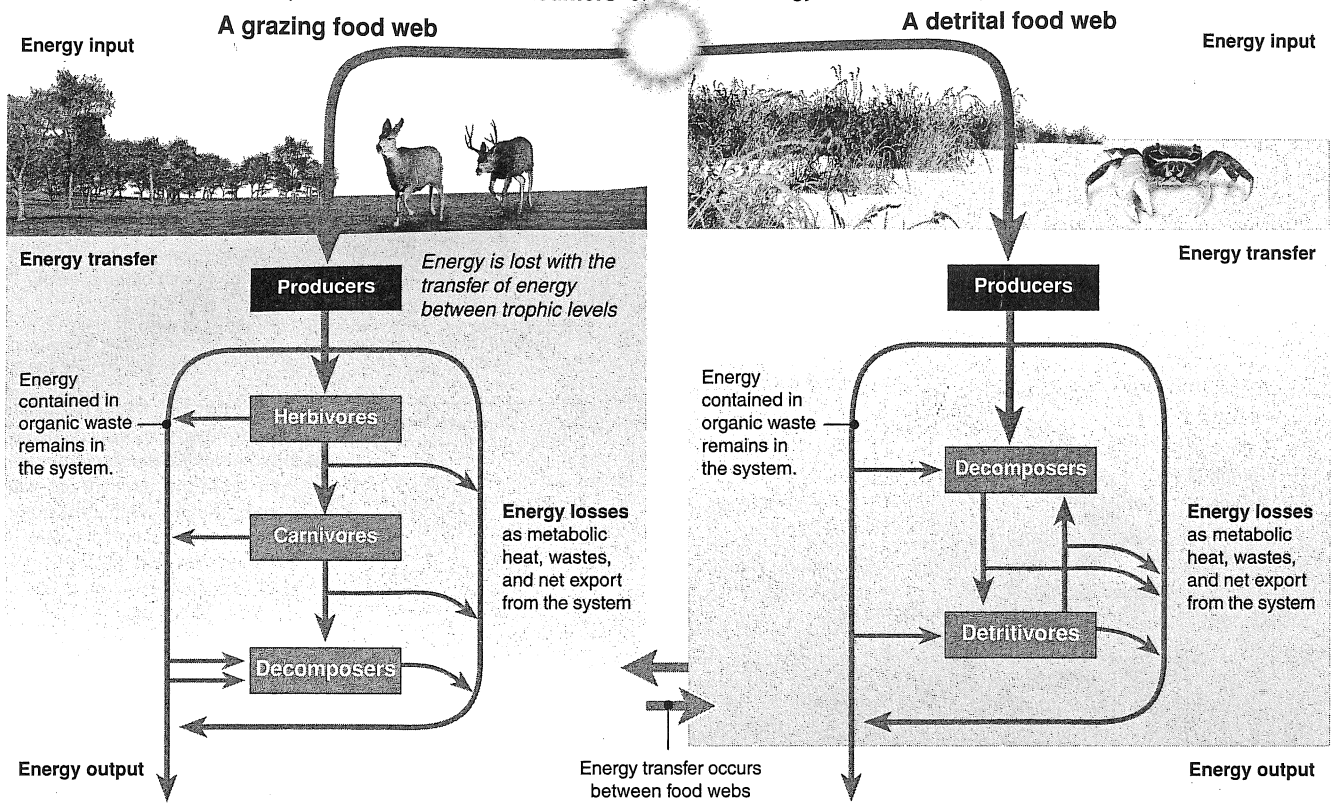
4. (a) Use the food chains created above to help you to draw up a **food web** for this community. Use the information supplied to draw arrows showing the flow of **energy** between species (only energy **from** the detritus is required).

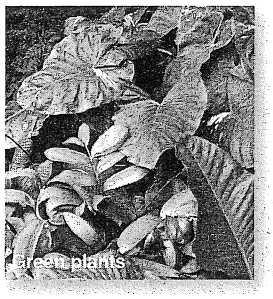
(b) Label each species to indicate its position in the food web, i.e. its trophic level (**T1, T2, T3, T4, T5**). Where a species occupies more than one trophic level, indicate this, e.g. **T2/3**:

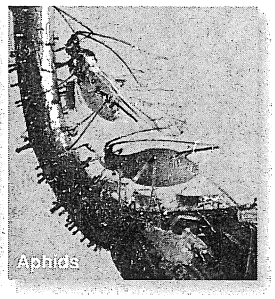


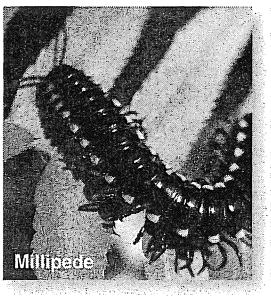
Energy Inputs and Outputs

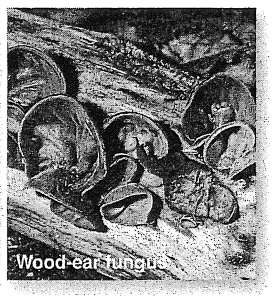
Within ecosystems, organisms are assigned to **trophic** levels based on the way in which they obtain their energy. **Producers** or **autotrophs** manufacture their own food from simple inorganic substances. Most producers utilise sunlight as their energy source for this, but some use simple chemicals. The **consumers** or **heterotrophs** (herbivores, carnivores, omnivores, decomposers, and detritivores), obtain their energy from other organisms. Energy flows through trophic levels rather inefficiently, with only 5-20% of usable energy being transferred to the subsequent level. Energy not used for metabolic processes is lost as heat.











Producers (green plants, algae, and some bacteria) make their own food from simple inorganic carbon sources (e.g. CO_2). Sunlight is the most common energy source for this process.

Consumers: Consumer organisms (animals, non-photosynthetic protists, and some bacteria) rely on other living organisms or organic particulate matter for both their energy and their source of carbon. **First order consumers**, such as aphids (left), feed directly on producers. **Second** (and higher) **order consumers**, such as ladybugs (centre) feed on other consumers. **Detritivores** consume (ingest and digest) detritus (decomposing organic material) from every trophic level. In doing so, they contribute to decomposition and the recycling of nutrients. Common detritivores includes millipedes (right), woodlice, and many terrestrial worms.

Decomposers (fungi and some bacteria) obtain their energy and carbon from the extracellular breakdown of (usually dead) organic matter (DOM). Decomposers play a central role in nutrient cycling.

1. Describe the differences between **producers** and **consumers** with respect to their role in energy transfers:

_____

_____

2. With respect to energy flow, describe a major difference between a detrital and a grazing food web: _____

_____

_____

3. Distinguish between detritivores and decomposers with respect to how their contributions to nutrient cycling:

_____

_____