resemble a web rather than a simple chain and are referred to as **food webs**. So, a food web is a pictorial representation of the feeding relationship between organisms in an ecosystem and consists of interlocking food chains.

Detritus food chains begin with dead organic matter (*detritus*) and goes from non-living organic matter to detritus-feeding organisms (*detritivores*) and their predators. A large amount of organic matter is generated by the death of plant's parts, animals and their excretion products in all ecosystems. Hence, detritus food chain is present in all ecosystems.

There is one notable difference in the flow of energy between trophic levels in the grazing and detritus food chains. In the grazing food chain, the flow is unidirectional, with net primary production providing the energy source for herbivores, herbivores providing the energy for carnivores, and so on. In the detritus food chain, the flow of energy is not unidirectional. The waste materials and dead organic matter in each of the consumer trophic levels are 'recycled,' returning as an input to the dead organic matter at the base of the detritus food chain.

The flow of energy in a single food chain; either grazing or detritus, is termed the **single-channel energy flow model**. However, in nature, that is rarely the case. In all ecosystems, the grazing and detritus food chains are interconnected, not all food eaten by herbivores is actually assimilated; some (such as undigested fecal matters) is diverted to the detritus pathway. The **Y-shaped model** (or *two-channel energy flow model*) explains the connection between a grazing and a detritus food chain.

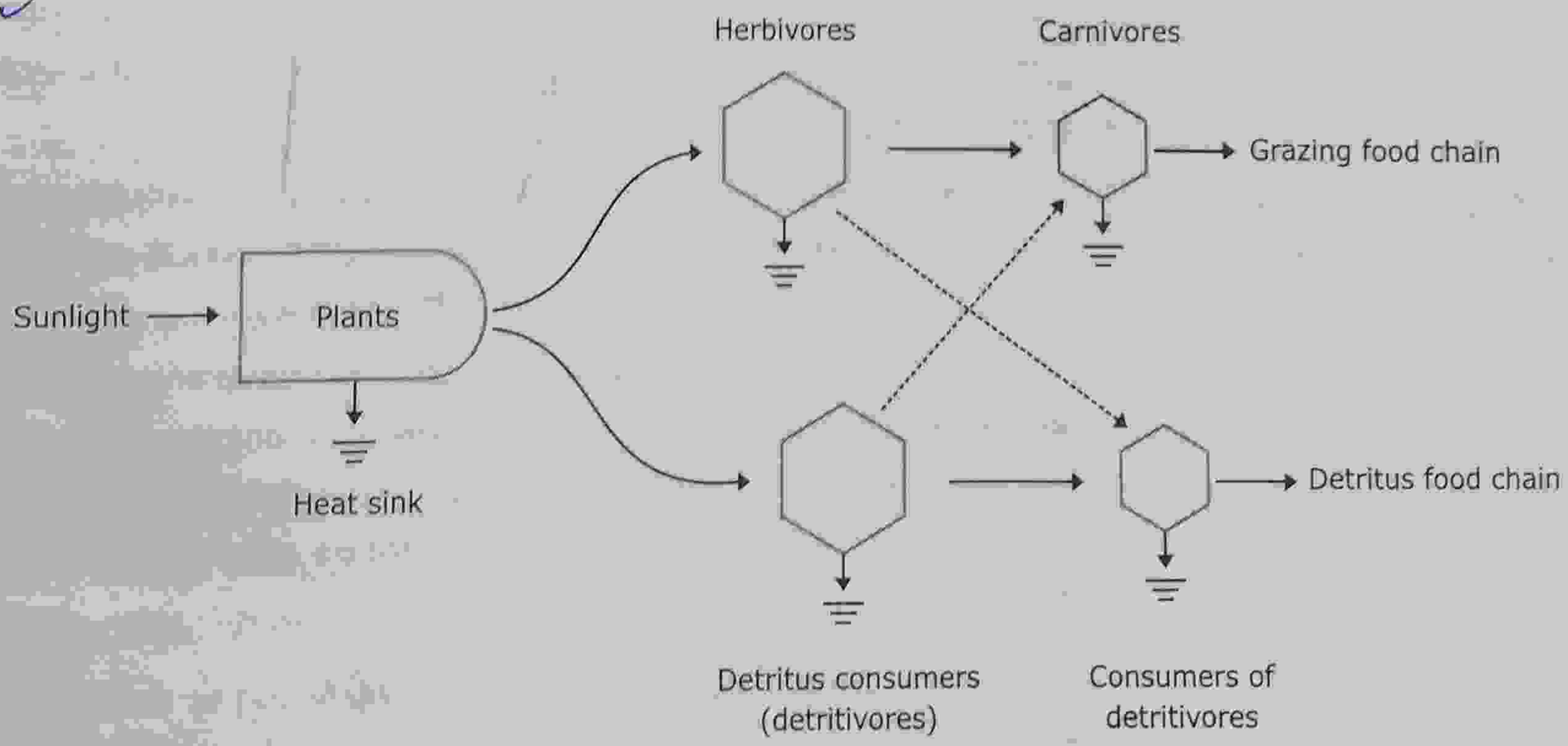


Figure 2.6 Y-shaped or two-channel energy flow diagram. Under natural conditions, the two food chains namely the grazing food chain and detritus food chain are not completely isolated from one another. The grazing food chain beginning with green plants goes to herbivores and their consumers. In the detritus food chain, beginning with dead organic matter passes to detritivores and their consumers. For instance, dead bodies of small animals that were once part of the grazing food chain become incorporated in the detritus food chain. Functionally, the distinction between the two is of time lag between the direct consumption of living plants and ultimate utilization of dead organic matter. Adapted from *Fundamental of Ecology* by Odum and Barrett.

Although, most of the natural ecosystems possess both grazing and detritus types of food

2.3.1 Food chains

A classic paper by Lindeman (1942) laid the foundations of ecological energetics. He attempted to quantify the concept of food chains by considering the efficiency of energy transfer between trophic levels. The first trophic level belongs to the primary producers, the second level to the herbivores (primary consumers), and the higher levels of the carnivores (secondary consumers). Some consumers occupy a single trophic level, but many others, such as omnivores, occupy more than one trophic level. The relationship between one trophic level and adjacent trophic levels may be described by a food chain.

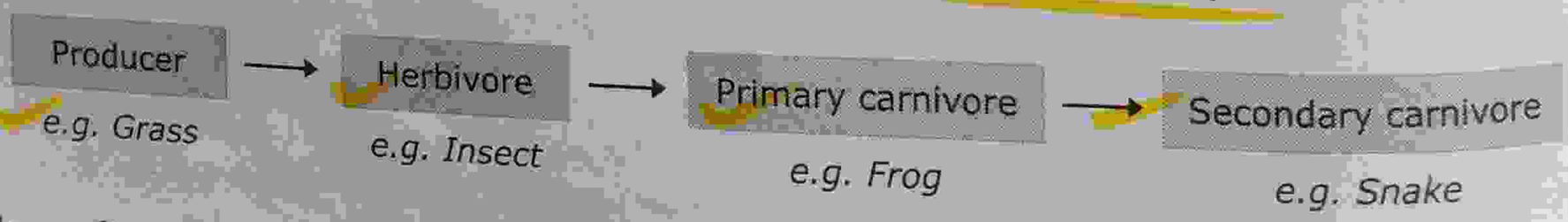
'*The transfer of food energy from producers (plants) through a series of organisms that consume and are consumed is termed as a* ***food chain****.*' A food chain shows the movement of energy through a system by indicating the path of food from a producer to a final consumer. In general, food chains have 3 to 5 trophic links with 15 to 20 species. The length of food chain also may reflect the physical characteristics of a particular ecosystem. A harsh arctic landscape has a much shorter food chain than a temperate or tropical one.

Why are food chains relatively short? There are two main hypotheses. One, the **energetic hypothesis**, suggests that the length of a food chain is limited by the inefficiency of energy transfer along the chain. As we know, only about 10% of the energy stored in the organic matter of each trophic level is converted to organic matter at the next trophic level. At each transfer, a proportion (often as high as 80% to 90%) of the potential energy is lost as heat. Therefore, the shorter the food chain — or the nearer the organism to the first trophic level — the greater the energy available to that population. The second hypothesis, the **dynamic stability hypothesis**, proposes that long food chains are less stable than short chains. Population fluctuations at lower trophic levels are magnified at higher levels, potentially causing the local extinction of top predators. This hypothesis predicts that food chains should be shorter in unpredictable environments. Most of the data available support the energetic hypothesis.

Types of food chains

Within any ecosystem, there are two major food chains: the **grazing food chain** and the **detritus food chain**. The distinction between these two food chains is the source of energy for primary consumers. In the grazing food chain, the source of energy is living plant biomass (or net primary production). In the detrital food chain, the source of energy is dead organic matter or detritus.

Grazing food chains begin with photosynthetic plants (primary producers). Primary consumers (or herbivores) form the second link in the grazing food chain. They gain their energy by consuming primary producers. Secondary consumers (or primary carnivores), the third link in the chain, gain their energy by consuming herbivores. Tertiary consumers (or secondary carnivores) are animals that receive their energy by consuming primary carnivores.



More often than not, such simple food chains are oversimplified versions of the reality of feeding relationships. Instead, there are often multiple and interconnecting pathways, as well as numbers of different species involved at each trophic level. These complex pathways