Carbohydrates consist of sugars, and the polymerized products of sugars are called *polysaccharides*. Sugars represent convenient molecules for the rapid oxidation and release of energy. The polysaccharides play an important structural role (as in cellulose) or can be used as a cellular reserve of carbon and energy (as in starch).

Lipids and related compounds are critical in the construction of cellular membranes. Some fats also form reserve sources. A number of growth factors or hormones involve lipid materials. *Phospholipids* are the primary components of biological membranes.

The maintenance of cellular integrity requires the selective uptake of nutrients. One class of nutrients is the *macronutrients*, and these are used in large amounts. The *micronutrients* and trace nutrients are used in low concentrations; some of these compounds become toxic if present at too high a level.

In a *defined medium*, all components added to the medium are identifiable chemical species. In a *complex medium*, one or more components are not chemically defined (e.g., yeast extract).

SUGGESTIONS FOR FURTHER READING

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PROBLEMS

2.1. Briefly compare procaryotes with eucaryotes in terms of internal structure and functions.

2.2. What are the major classes of fungi? Cite the differences among these classes briefly.

2.3. Briefly describe distinct features of actinomycetes and their important products.

2.4. Briefly compare protozoa with algae in terms of their cellular structures and functions.

2.5. What are major sources of carbon, nitrogen, and phosphorus in industrial fermentations?

2.6. Explain the functions of the following trace elements in microbial metabolism: Fe, Zn, Cu, Co, Ni, Mn, vitamins.

2.7. What are chelating agents? Explain their function with an example.

2.8. Cite five major biological functions of proteins.

2.9. Briefly describe the primary, secondary, tertiary, and quaternary structure of proteins. What could happen if you substituted a tyrosine for a cysteine in the active site? What might happen if the substitution occurred elsewhere?