THE RESTAURANT FOR MICROBES

Additional Resource

To survive, grow and reproduce cellular microbes need to absorb and digest a range of nutrients from their environment.

Energy

Either derived from sunlight or from compounds in the environment. Mainly stored in a molecule called adenosine triphosphate (ATP), which is required for three types of cellular work:

1) drive biochemical reactions;

2) drive active transport of solutes into and out of the cell;

3) perform mechanical work e.g. powering the rotation of flagella to enable bacteria to swim in liquid.

Electrons

The transfer of electrons from an electron donor to an electron acceptor in oxidation-reduction (redox) reactions releases energy in small manageable packets. The electron transport chains (ETC) involved in photosynthesis and respiration use a series of redox reactions.

Carbon

Necessary to make the cell's essential building blocks e.g. amino acids, nucleic acids, fatty acids, monosaccharides (simple sugars). Energy and electrons are needed to make macromolecules including proteins, nucleic acids (DNA, RNA), and polysaccharides from these building blocks.

Microbiologists combine the terms in the table below to describe the nutritional types of microbes.

Energy Source	Electron source	Carbon source	Nutritional type	Microbe examples
Light *Photo-*	Inorganic *-litho-*	CO_2 *-autotroph*	Photolithoautotroph	Some bacteria (eg Cyanobacteria, Purple- and Green-sulphur bacteria); some archaea; some protists
		Organic - heterotroph	-	None known
	Organic *-organo-*	CO_2 *-autotroph*	-	None known
		Organic - heterotroph	Photoorganoheterotroph	Some bacteria (eg Purple and Green non-sulphur bacteria)
Chemical compounds *Chemo-*	Inorganic *-litho-*	CO_2 *-autotroph*	Chemolithoautotroph	Some bacteria (eg sulphur-, hydrogen-, iron-, and nitrogen-oxidising bacteria); some archaea (eg methanogens; ammonia-oxidising archaea)
		Organic - heterotroph	Chemolithoheterotroph	Some sulphur-oxidising bacteria
	Organic *-organo-*	CO_2 *-autotroph*	-	None known
		Organic - heterotroph	Chemoorganoheterotroph	Many bacteria (including most pathogens); many archaea, many protists, all fungi.

Nitrogen

A component of proteins, nucleic acids (DNA, RNA) and amino sugars. Nitrogen-fixing microbes can convert atmospheric N_2 into ammonia (NH_3). Other microbes have to gain usable nitrogen from the environment (e.g. ammonia, nitrate, nitrite, amino acids, amino sugars etc).

Phosphorous

A component of the energy storage molecule ATP, DNA, RNA, nucleotides, phospholipids, phosphoproteins. Usually obtained in the form of inorganic phosphates.

Sulphur

A component of the amino acids cysteine and methionine and several other important cellular components including glutathione and iron-sulphur proteins. Inorganic sources include sulphide and sulphate. Organic sources include cysteine, methionine, glutathione.

Metal ions

Some enzymes contain non-protein components (cofactors) that are important for their activity. Many cells require trace amounts of various metal ions (eg iron, zinc, copper, magnesium, manganese, molybdenum, nickel, vanadium, cobalt, tungsten) because they are cofactors in specific enzymes. Iron is also an important component of several proteins involved in redox reactions in ETCs eg cytochromes and ferredoxins.