Preface

Plant species produce a variety of secondary metabolites in their cells. According to Kossel, who introduces the term 'secondary metabolites'. "Primary metabolites are present in every plant cell that is capable of division, where as secondary metabolites are present only accidentally and are not essential for plant life." However, many secondary plant products are known to have important roles in growth, development and adaptation of plant species. Some provide defence against micro-organisms, insect parasites and herbivores. Several classes of secondary products are 'induced' by infection, wounding, or herbivory. Genetic variation in the speed and extent of such induction may account at least in part for the difference between resistant and susceptible varieties. The biosynthesis of several plant secondary compounds occurs in specialized organs and plant cells at precise developmental stages. They are important in plant metabolism either due to their own biological activities or as precursors to active compounds. The two types of metabolisms are strongly interlinked. So it is often difficult to decide whether a metabolite is a primary or secondary one. A major distinction is that primary metabolites are few in number and are common to all plant species. Many secondary metabolites are derived from the products of primary metabolism although many have their own independent metabolic pathways.

Secondary products are generally small molecules when compared to the size of macro molecules such as proteins and nucleic acids. Their molecular structure is often based on a multiple ring hydrocarbon skeleton to which atoms of other elements (oxygen and nitrogen) are joined but some compounds have a straight chain molecular structure. Secondary metabolic products from plants are classified in many different ways - by their function, by the species from which it is derived; or by chemical composition.

Secondary metabolites have economic value in modern industry. They are natural sources to chemical compounds important in the pharmaceutical industry, precursors to important vitamins and raw material to many industrial products.

It has been estimated that about 30 per cent of the world's plant species have been used for medicinal purpose. Some products act on the autonomic and central nervous systems. Morphine, the principal alkaloid of the opium poppy is used for the relief of severe pain. Compounds like cannabis from hemp, caffeine and theobromine, from coffee and cocoa respectively and cocaine from *Erythroxylim coca*, stimulate mental activity, where as reserpine from *Rauwolfia* spp. depresses mental activity. The alkaloid atropine from solanaceous plants is used to dilate the pupil of the eye during surgery. Steroidal glycosides of *Digitalis* spp. are mainly used to impart a slowing and strengthening effect of heart muscles. Quinidine from cinchona bark is used to control atrial fibrillation.

Many non pharmaceutical products important in industry are also derived from plants [dyes, green chlorophyll, saffron yellow dye, purple or red colours from the roots of madder (*Rubia tinctorum*)]. Many secondary products provide protection from pests and diseases. The seed extract of neem (*Azadirachta indica*), root powder of *Derris* spp., flowers of *Chrysanthemum cinerariaefolium* and leaves and stalks of *Nicotiana* have insecticidal properties. *Schoenocaulon officionale* (Sabadilla) is used as a rodent poison. Therefore, the information given in this book will help to the teachers, students, researchers and pharmaceuticals also.

Pigments are chemical compounds which reflect only certain wavelengths of visible light. This makes them appear "colourful". Flowers, corals and even animal skin contain pigments which give them their colours. More important than their reflection of light is the ability of pigments to absorb certain wavelengths. Because they interact with light to absorb only certain wavelengths, pigments are useful to plants and other autotrophs organisms which make their own food using photosynthesis. In plants, algae and cyanobacteria, pigments are the means by which the energy of sunlight is captured for photosynthesis. However, since each pigment reacts with only a narrow range of the spectrum, there is usually a need to produce several kinds of pigments, each of a different colour, to capture more of the sun's energy. There are three basic classes of pigments.

1. **Chlorophylls** are greenish pigments which contain a porphyrin ring. This is a stable ring-shaped molecule around which electrons are free to migrate. Because the electrons move freely, the ring has the potential to gain or lose electrons easily and thus the potential to provide energized electrons to other molecules. This is the fundamental process by which chlorophyll "captures" the energy of sunlight. There are several kinds of chlorophyll, the most important being chlorophyll "a". This is the molecule which makes photosynthesis possible, by passing its energized electrons on to molecules which will manufacture sugars. All plants, algae and cyanobacteria which photosynthesize contain chlorophyll "a". A second kind of chlorophyll is chlorophyll "b", which occurs only in "green algae" and in the plants. A third form of chlorophyll which is common is (not surprisingly) called chlorophyll "c" and is found only in the photosynthetic members of the Chromista as well as the dinoflagellates. The difference between the chlorophylls of these major groups was one of the first clues that they were not as closely related as previously thought.

2. **Carotenoids** are usually red, orange, or yellow pigments and include the familiar compound carotene, which gives carrots their colour. These compounds are composed of two small six-carbon rings connected by a "chain" of carbon atoms. As a result, they do not dissolve in water and must be attached to membranes within the cell. Carotenoids cannot transfer sunlight energy directly to the photosynthetic pathway, but must pass their absorbed energy to chlorophyll. For this reason, they are called accessory pigments. One very visible accessory pigment is fucoxanthin the brown pigment which colours kelps and other brown algae as well as the diatoms.

3. **Phycobilins** are water-soluble pigments and are therefore found in the cytoplasm, or in the stroma of the chloroplast. They occur only in Cyanobacteria and Rhodophyta. The picture at the right shows the two classes of phycobilins which may be extracted from these "algae". The vial on the left contains the bluish pigment phycocyanin, which gives the Cyanobacteria their name. The vial on the right contains the reddish pigment phycoerythrin, which gives the red algae their common name. Phycobilins are not only useful to the organisms which use them for soaking up light energy; they have also found use as research tools. Both pycocyanin and phycoerythrin fluoresce at a particular wavelength. That is, when they are exposed to strong light, they absorb the light energy and release it by emitting light of a very narrow range of wavelengths. The light produced by this fluorescence is so distinctive and reliable, that phycobilins may be used as chemical "tags". The pigments are chemically bonded to antibodies, which are then put into a solution of cells. When the solution is sprayed as a stream of fine droplets past a laser and computer sensor, a machine can identify whether the cells in the droplets have been "tagged" by the antibodies. This has found extensive use in cancer research, for "tagging" tumor cells.

Therefore, I hope this book will be useful to under-graduate as well as post-graduate students in Science Faculty, in Agriculture, Food Technology, Biotechnology, Biochemistry, Horticulture, Home Science and Industrial Sectors.

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