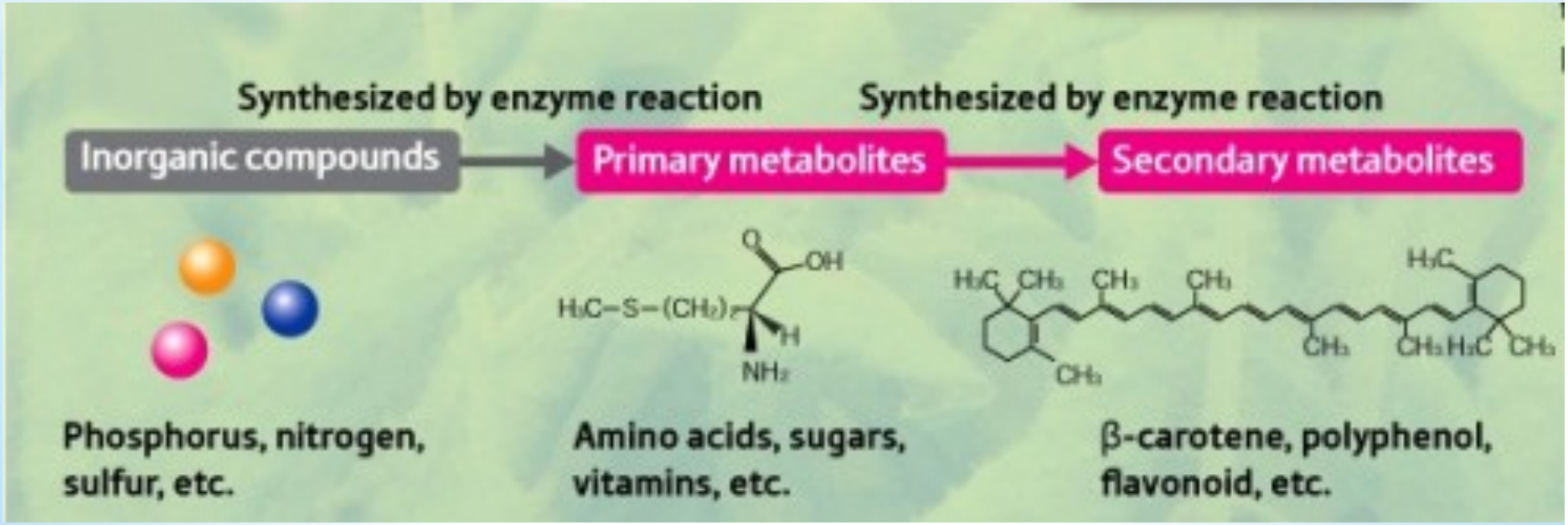
SECONDARY METABOLITES IN PLANTS



* **Plant secondary metabolites** are a diverse group of molecules that are involved in the adaptation of plants to their environment but are not part of the primary biochemical pathways of cell growth and reproduction.

* These compounds are played many important rules in plant life such as involved in defense against herbivores and pathogens, regulation of symbiosis, control of seed germination, and chemical inhibition of competing plant species (allelopathy), and therefore are an integral part of the interactions of species in plant and animal communities and the adaptation of plants to their environment.

Table 4. Chemical protection of plants (general strategies)

Defense level	Compounds	Biological activity
1. Surface	Cuticular waxes	repellent, antibiotic, hydrophobic barrier
2. Carbohydrates/polymers	Cellwall (cellulose, lignin)	reduced digestibility
	Callose, lignin (wounds)	penetration barrier, antibiotic
4. Proteins	Lectins	cytotoxic,
	Protease inhibitors	reduced digestibility
	Hydrolytic enzymes (Lysozyme, chitinase, Esterase, DNAse, RNAse, Phosphatase, glycosidases)	degradation of microbial constituents
	Oxidases (Peroxidase, Phenoloxidase)	Degradation of microbial phytotoxins
4. Secondary metabolites	Flavonoids/anthocyanins	antimicrobial, insectistatic,
	Phenylpropanoids	antimicrobial
	Alkaloids	toxic for vertebrates, arthropods, antimicrobial
	Non-protein amino acids	toxic for animals, antimicrobial
	Cyanogenic glycosides	toxic for animals, antimicrobial
	Glucosinolates	repellent for animals, antimicrobial
	Terpenes	repellent for animals, antimicrobial

* In addition, plant secondary metabolites are also associated with improved nutritive value and may have beneficial effects on animal health.
* Growing interest in the potential health-promoting effects of plant secondary metabolites in human foods has prompted research on their potential to prevent or treat cancer, circulatory disease, and viral infection.
* The mechanisms by which these substances have beneficial effects on health may also be related to their toxic effects, and the difference between toxicity and beneficial effects may be dose- and structure-dependent.

MAIN GROUPS OF PLANT SECONDARY METABOLITES

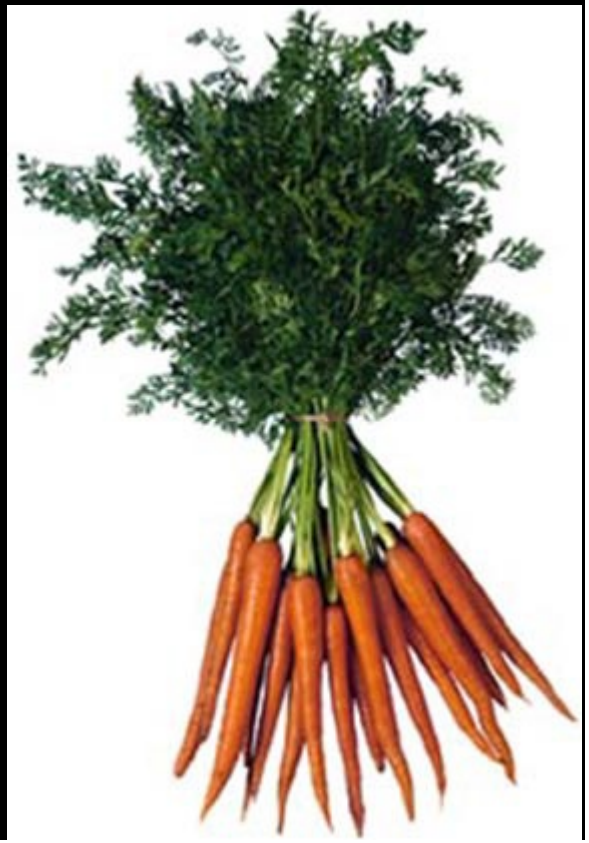
A/ Terpenoids

B/ Nitrogen containing secondary metabolites

C/ Phenolic compounds

THE TERPENOIDS

- ISOPRENE C5 is the basic unit of the terpenoids
- Production in Plants: * Flowers
  * Leaves
  * Fruit
- Biological Role(volatile and non volatile):
  -Flavour, fragrance, scent
  -Antibiotics
  -Hormones
  -Membrane lipids
  -Insect attractants
  -Insect antifeedants



TERPENOIDS --IMPORTANT MOLECULES !

C5-hemiterpenes -e.g. isoprene

C10-monoterpenes -e.g. limonene

C15-sesquiterpene -e.g. abscisic acid (ABA)

C20-diterpene -e.g. gibberellin

C30-triterpne -e.g. brassinosteroids

C40-tetraterpenes -e.g. carotenoids

> carbons -polyterpenes-e.g. ubiquinones, rubber

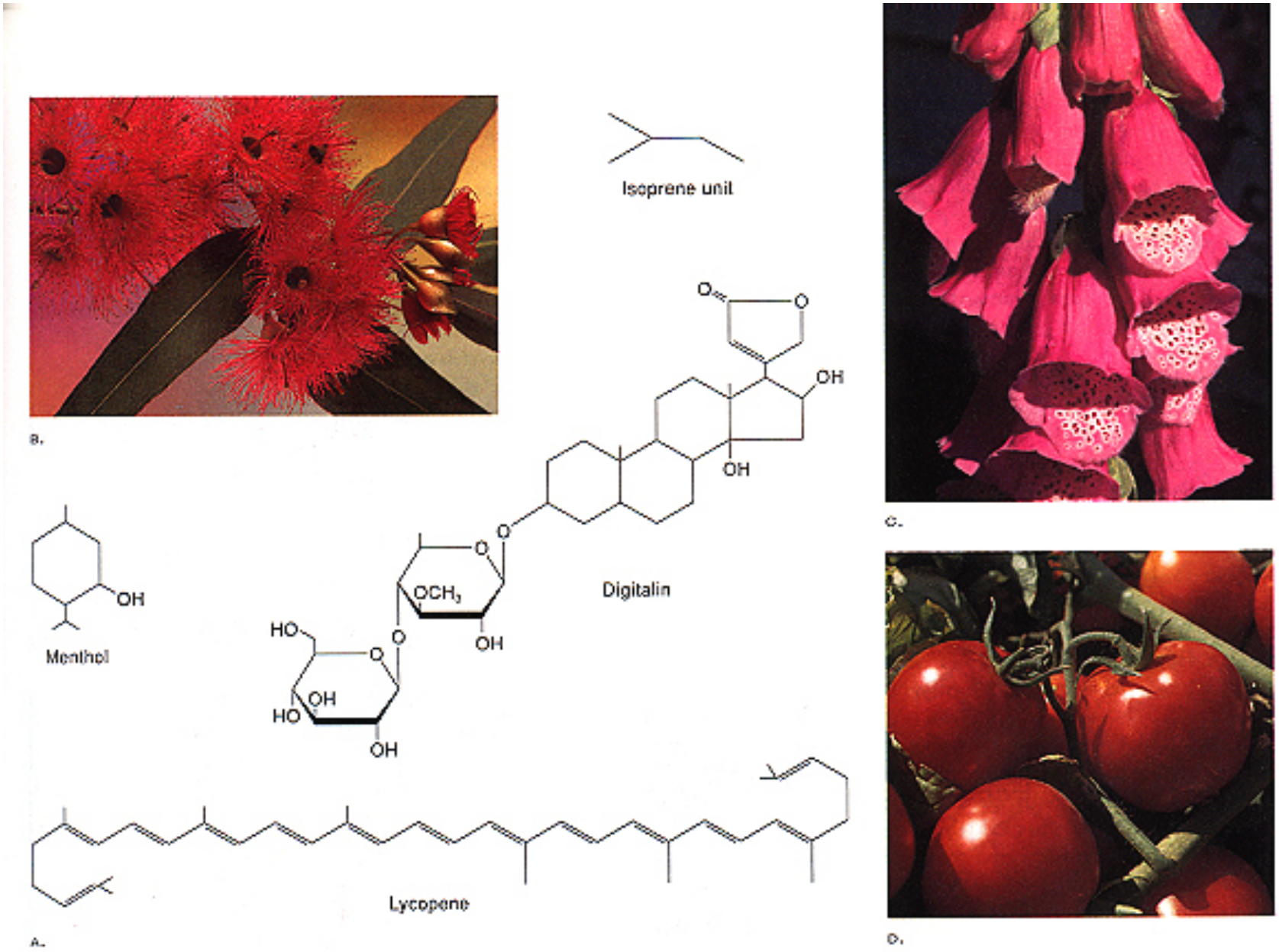


FIGURE 2.14

(a) Structures of three terpenoids. (b) *Eucalyptus* species produce menthol. (c) The purple foxglove (*Digitalis purpurea*) is a source of digitalin. (d) Lycopene is the main red pigment of tomatoes.

Nitrogen containing compounds!

- **Alkaloids (pseudo-, True-, proto-)**

✓ **Extremly heterogenous group**

✓ **alkali like**

✓ **have important pharmacological properties**

✓ **further classified in to many groups**

- **Pyridine alkaloids , e.g. nicotine**
- **pyrrolidine alkaloids , e.g. stachydrine**
- **piperidine alkaloids , e.g. coniine**
- **tropane alkaloids , e.g. atropine**
- **quinoline alkaloids , e.g. quinine**
- **Isoquinoline alkaloids , e.g. berberine**
- **Quinolizidine alkaloids , e.g. lupinine**
- **Indol alkaloids , e.g. resrpine**
- **Imidazol alkaloids , e.g. pilocarpine**

❑ Cyanogenic glycosides

- ✓ widely distributed in plants
- ✓ volatile poisons
- ✓ e.g. Lotustraline

❑ Glucosinolates

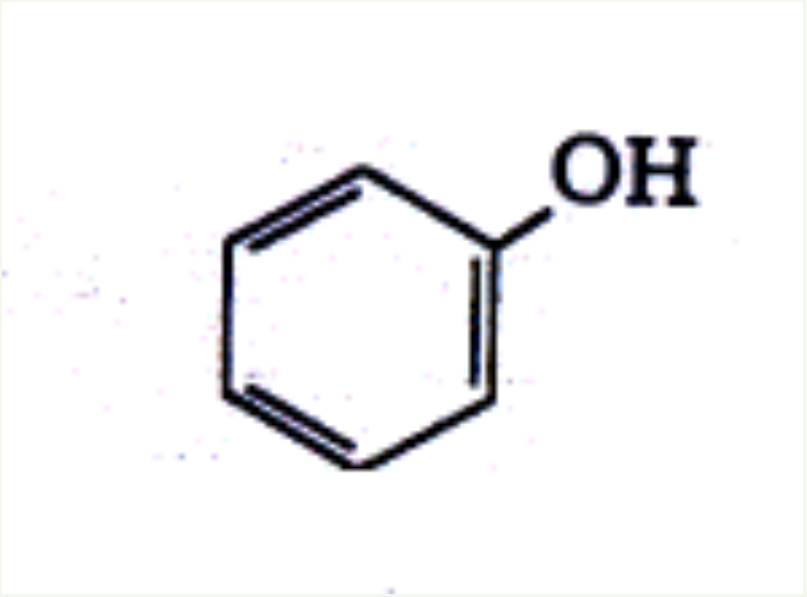
- ✓ contain nitrogen and sulpher
- ✓ volatile toxins
- ✓ strong deterrent

Non-Protein amino acids

- found in plants of the family leguminosae
- e.g. Canavanine resemble in structure with arginine
- there are not incorporated in to protiens

Phenolics

- Plants produce a variety of compounds that contain one or more phenol groups - called phenolics
- Thousands of phenolics occur in plants



Phenolics

- Large group of diverse compounds
- Many serve as defense compounds against herbivores and pathogens
- Some function in support – primary cmpd
- Some attract pollinators
- Some absorb UV light
- Some reduce growth of competitors

Tannins

- They are high molecular weight phenolic compounds
- They are widely distributed in plants.
- capable of precipitation of animal proteins

Uses of Tannins:

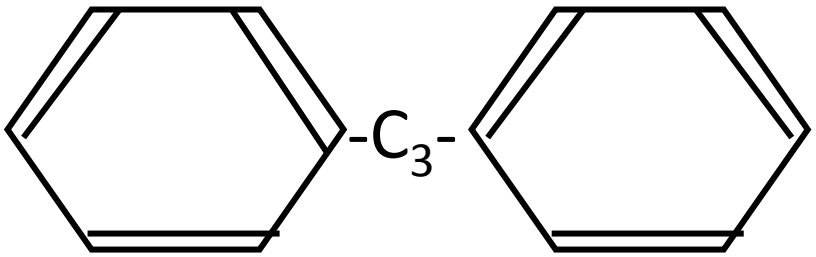
- 1) Antioxidant.
- 2) Antidiarrheal.
- 3) Antidote for heavy metals poisoning.
- 4)Treatment of burns, ulcers, inflammations
- 4) Astringent to stop bleeding (hemorrhage)
- 5)Treatment of Hemorrhoids.
- 6) Tanning industry.

Lignin a complex phenolic

- Primary metabolite - secondary cell wall component occurs in all vascular plants
- Structural function
- Also protective because deters herbivores due to its toughness
- Blocks growth of many pathogens because only small group of fungi can degrade

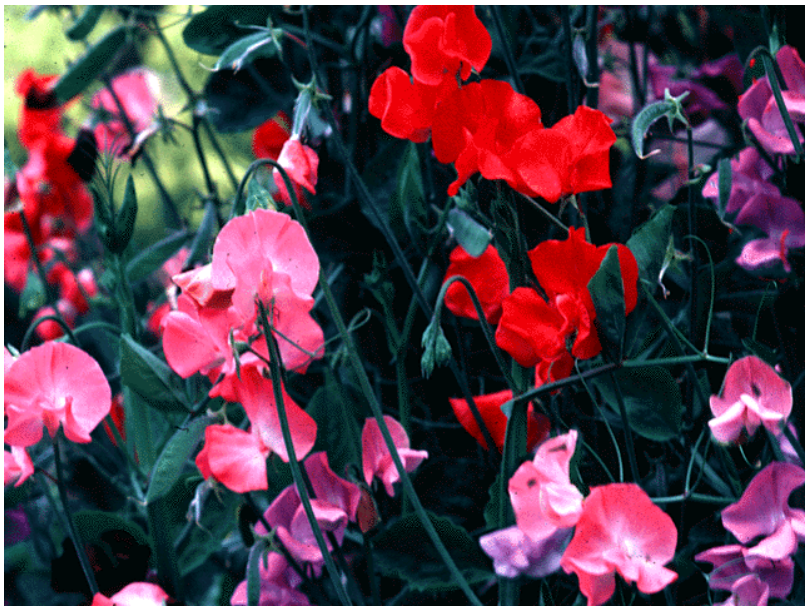
Flavinoids

- One of the largest classes of phenolics
- Carbon skeleton has 15 carbons with two benzene rings connected by a 3-C bridge



Anthocyanins

- Colored flavinoids - red, pink, blue, purple pigments
- Attract animal pollinators and seed dispersers



Flavones and Flavonols

- Also flower pigments
- Absorb UV not visible light - not visible to human eye but visible to many insects - maybe be attractants, nectar guides
- Also present in leaves where they protect against UV-B damage
- Appeared to be involved in legume roots in attracting N-fixing bacteria

Some applications of Important plants and their compounds in biotechnology

Green Tea (Camellia sinensis)

- Polyphenols from leaves
- anti-cancer inhibiting tumor initiation and cell proliferation
- anti-oxidant

Wine Grape (Vitis vinifera)

- Contains over 50 different flavonoid phenolics including resveratrol and catechins
- Reduces heart disease by inhibiting platelet aggregation, lowering LDL (low density lipoproteins) and acting as antioxidants

Ginger (Zingiber officinale)

- from the rhizome
- Over 12 compounds with anti-oxidant activities greater than vitamin E
- anti-tumor
- anti-emetic (inhibits vomiting)

Garli c (Allium sativum)
Onion (Allium cepa)

- Organo-sulfur compounds from leaves
- Anti-carcinogenic and anti-microbial
- Anti-atherosclerosis and anti-hypertensive
- Toxic in high amounts

Soybeans (Glycine max)

- Contains phytoestrogens like isoflavones
- Reduces health risks associated with menopause: osteoporosis and heart disease in women
- Reduces prostrate, colon and breast cancer