

Macromolecules of Biological system: Lipids

By
PRAMOD KUMAR MAHISH
Asst. Professor (Biotechnology)
Govt. Digvijay PG College Rajnandgaon (C.G.)
pramod.mahish@rediffmail.com

Introduction

- The lipids are a large and diverse group of naturally occurring organic compounds that are related by their solubility in nonpolar organic solvents (e.g. ether, chloroform, acetone & benzene) and general insolubility in water.
- Lipids are found to be water insoluble but they are found to be soluble in fat solvent.
- They include fats, oils, waxes and other related substances.
- The main biological functions of lipids include storing energy, signaling, and acting as structural components of cell membranes. Lipids have applications in the cosmetic and food industries as well as in nanotechnology.

BIOLOGICAL IMPORTANCE OF LIPIDS

- **ENERGY SOURCE:** Lipids act as fuel in the body. Lipids are found to be superior to carbohydrates and protein in providing energy to body with respect to their energy released by their oxidation. Lipids yield 9.5Kcal/gram whereas proteins and carbohydrates yield only about 4Kcal/gram.
- **NATURAL SOLVENT:** They are natural solvent in fat soluble vitamins.
- **ENERGY STORAGE:** They store energy in adipose tissues.
- **SKIN INSULATOR:** Lipid found in skin serve as thermal insulator.

BIOLOGICAL IMPORTANCE OF LIPIDS

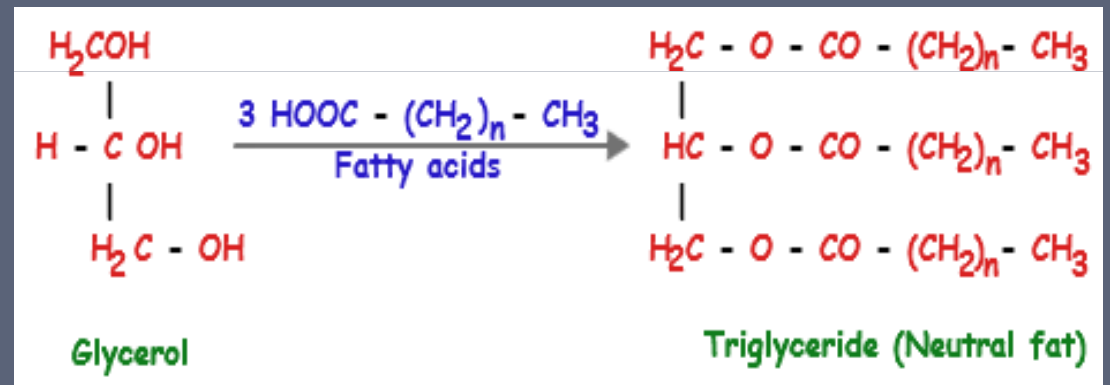
- **STRUCTURAL ROLE:** Lipids play a vital role in structure by being the important component of lipid bilayer in membrane. Especially phospholipids and cholesterol are important.
- **VITAMIN ABSORPTION:** Lipids are essential for the absorption of fat soluble vitamins like vitamin A, D, E and K.
- **NERVOUS SYSTEM:** Lipids are found to be important constituent of the nervous system because nerve cells found to contain greater amount of lipids they play vital role nerve cell insulation and impulse conduction.

Classification

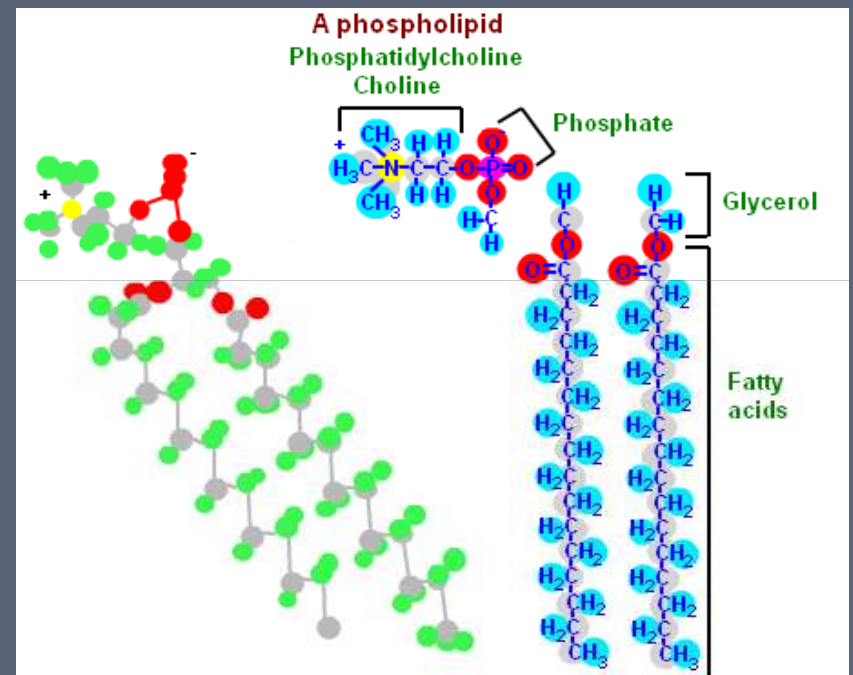
- **SIMPLE LIPID**

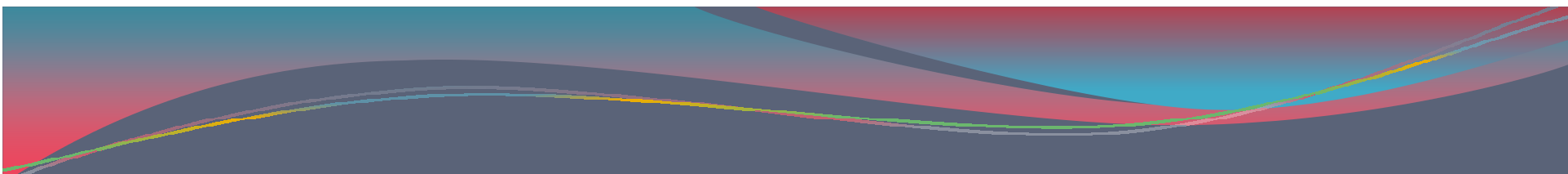
- They are formed of Fatty acid and Alcohols
- Further classified according to Alcohol present

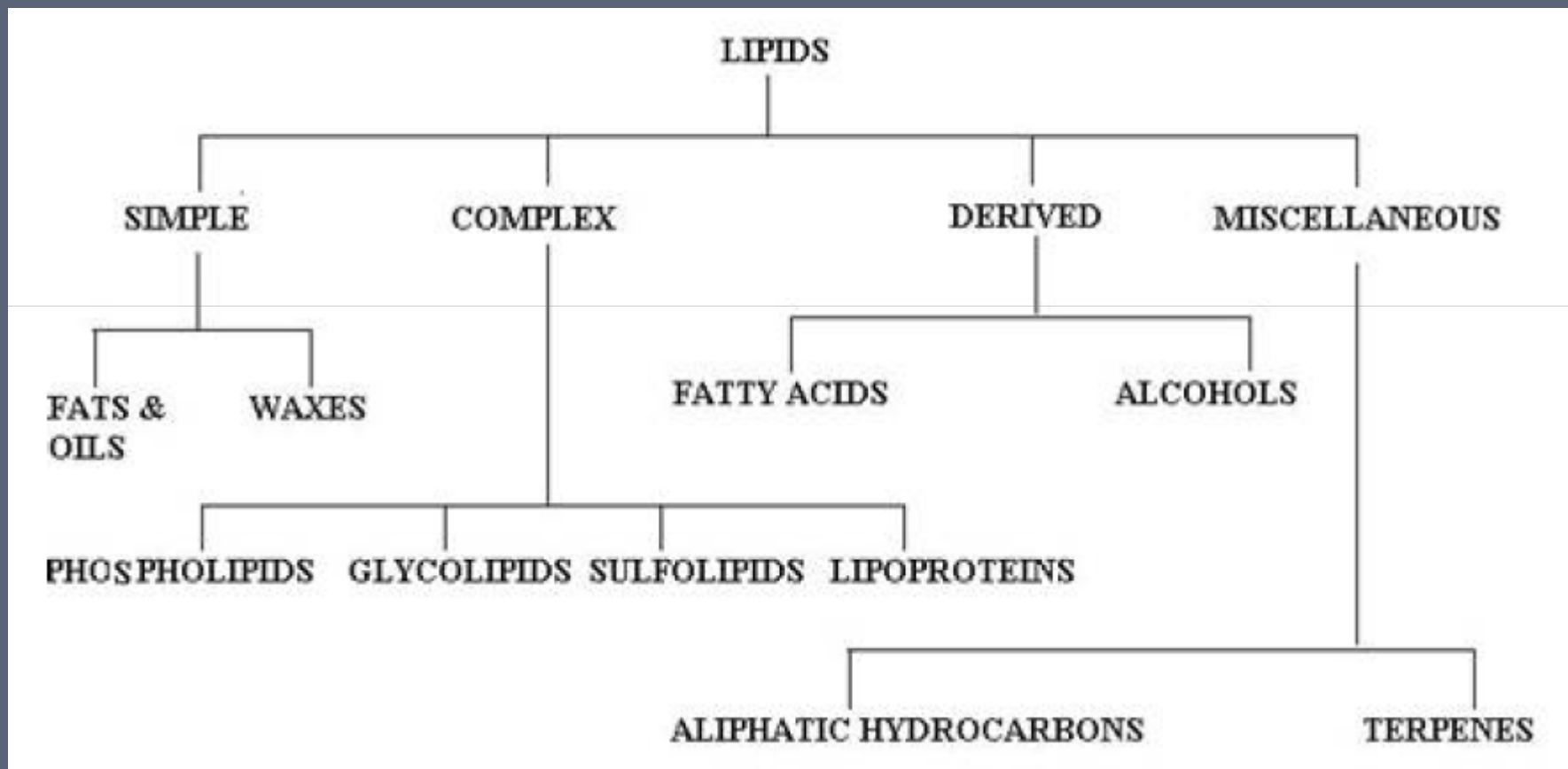
- Examples
- Fate: Triglyceride
- Wax: Beeswax, Carnauba wax



- **COMPOUND LIPID**
- They are formed of fatty acid with additional group.
- **PHOSPHOLIPIDS** - In addition to fatty acids and alcohol presence, they also contain phosphorous, nitrogenous bases and other substitution Groups.
- **GLYCOLIPIDS** - Lipids containing carbohydrates are referred as glycolipids.
- **LIPOPROTEINS** : When lipids contain protein then they are known as lipoproteins.



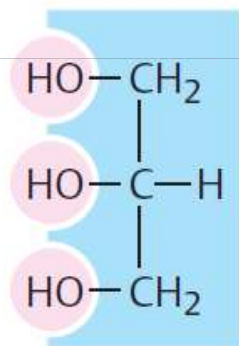
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- **DERIVED LIPIDS:** Derived lipids are lipids obtained upon hydrolysis of the simple and complex lipids and still retaining the characteristics of lipids. They are classified further into two types namely fatty acid, alcohol, steroids, terpenes, carotenoids etc.
 - **FATTY ACID:** They are the hydrolyzed products of simple and complex lipids. Their length varies between C₄ to C₃₀. Palmitic Acid C₁₆
 - **ALCOHOL:** It includes molecules with OH group as functional group. It also varies from simple straight chain alcohol like glycerol to complex cyclic alcohols like cholesterol.



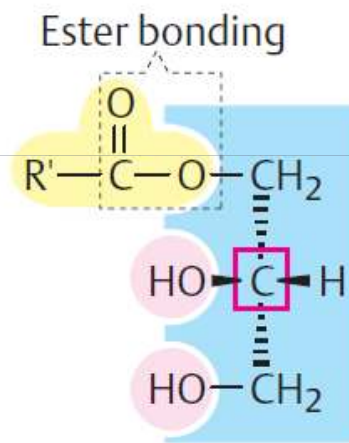
Fats

- Fats are esters of the trivalent alcohol glycerol with three fatty acids. When a single fatty acid is esterified with glycerol, the product is referred to as a monoacylglycerol (fatty acid residue = acyl residue).
- Formally, esterification with additional fatty acids leads to diacylglycerol and ultimately to triacylglycerol, the actual fat (formerly termed “triglyceride”).

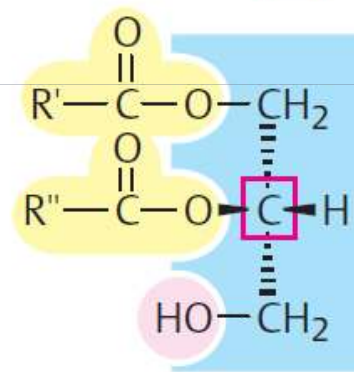
B. Structure of fats



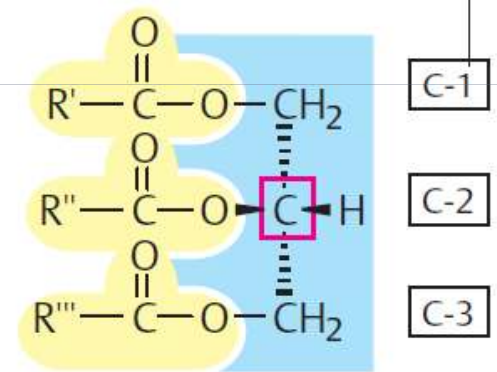
Glycerol



Monoacylglycerol



Diacylglycerol



Triacylglycerol = Fat

 Chiral center

sn number

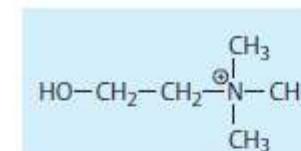
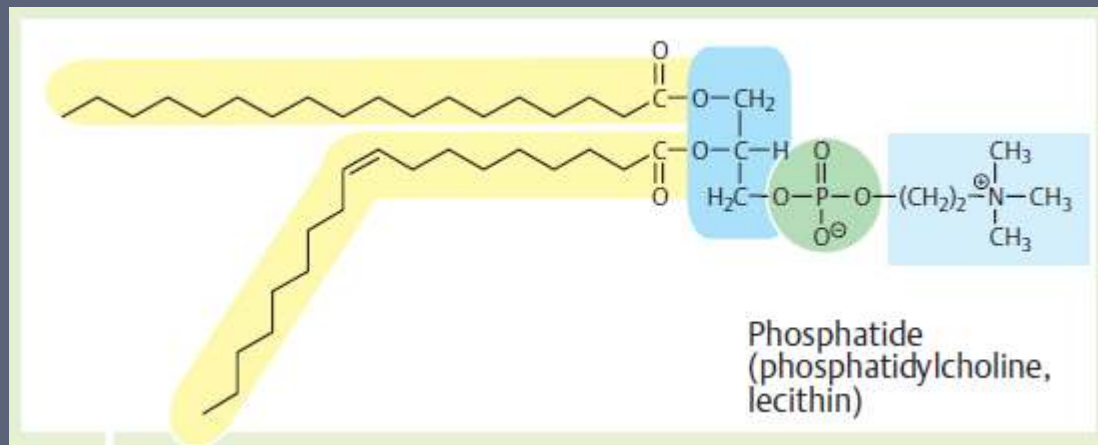
C-1

C-2

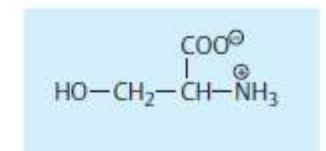
C-3

Phospholipids

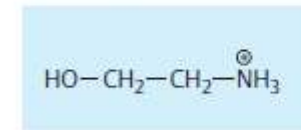
- phospholipids, are phosphate esters of diacylglycerol.
- Their phosphate residues are esterified with the hydroxyl group of an amino alcohol (*choline, ethanolamine, or serine*).
- *Phosphatidylcholine* is shown here as an example of this type of compound.



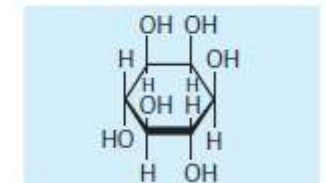
Choline



Serine



Ethanolamine



myo-Inositol

Glycolipids

- Glycolipids are present in all tissues on the outer surface of the plasma membrane.
- Galactosylceramide and glucosylceramide (known as cerebroside) are simple representatives of this group.
- Cerebrosides in which the sugar is esterified with sulfuric acid are known as sulfatides. Gangliosides are the most complex glycolipids.

Steroids

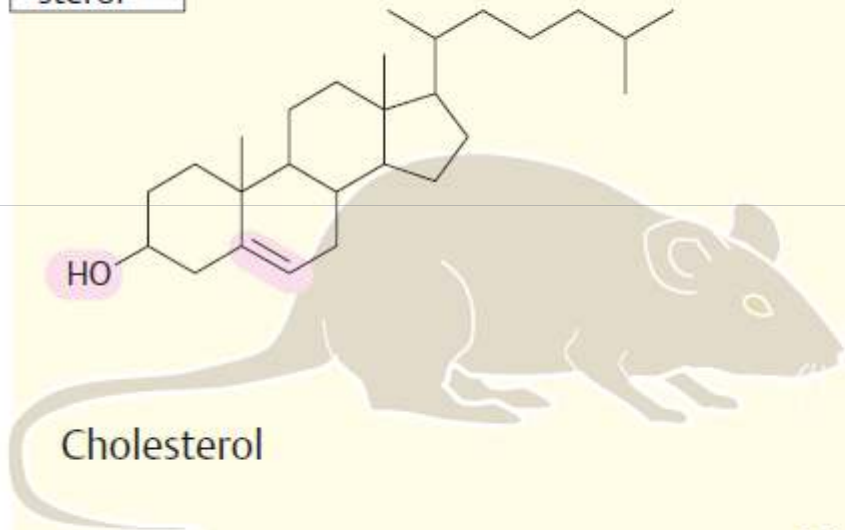
- The three most important groups of steroids are the *sterols*, *bile acids*, and *steroid hormones*. Particularly in plants, compounds with steroid structures are also found that are notable for their pharmacological effects— steroid alkaloids, digitalis glycosides, and saponins.
- Sterols are steroid alcohols. They have a β -positioned hydroxyl group at C-3 and one or more double bonds in ring B and in the side chain.
- The most important sterol in animals is cholesterol. Plants and microorganisms have a wide variety of closely related sterols instead of cholesterol—e. g., ergosterol, β -sitosterol, and stigmasterol.

Steroids

- Cholesterol - Cholesterol is present in all animal tissues, and particularly in neural tissue. It is a major constituent of cellular membranes, in which it regulates fluidity.
- Steroid hormones –
- The conversion of cholesterol to steroid hormones is of minor importance quantitatively, but of major importance in terms of physiology. The steroid hormones regulate metabolism, growth, and reproduction.
- Humans have six steroid hormones: progesterone, cortisol, aldosterone, testosterone, estradiol, and calcitriol.

A. Sterols

Animal
sterol



Cholesterol

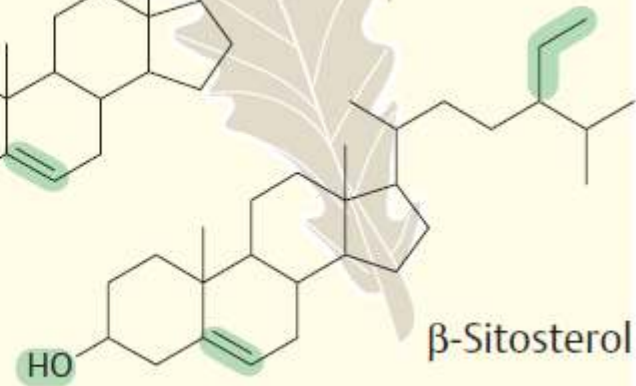
Ergosterol



Plant
sterols

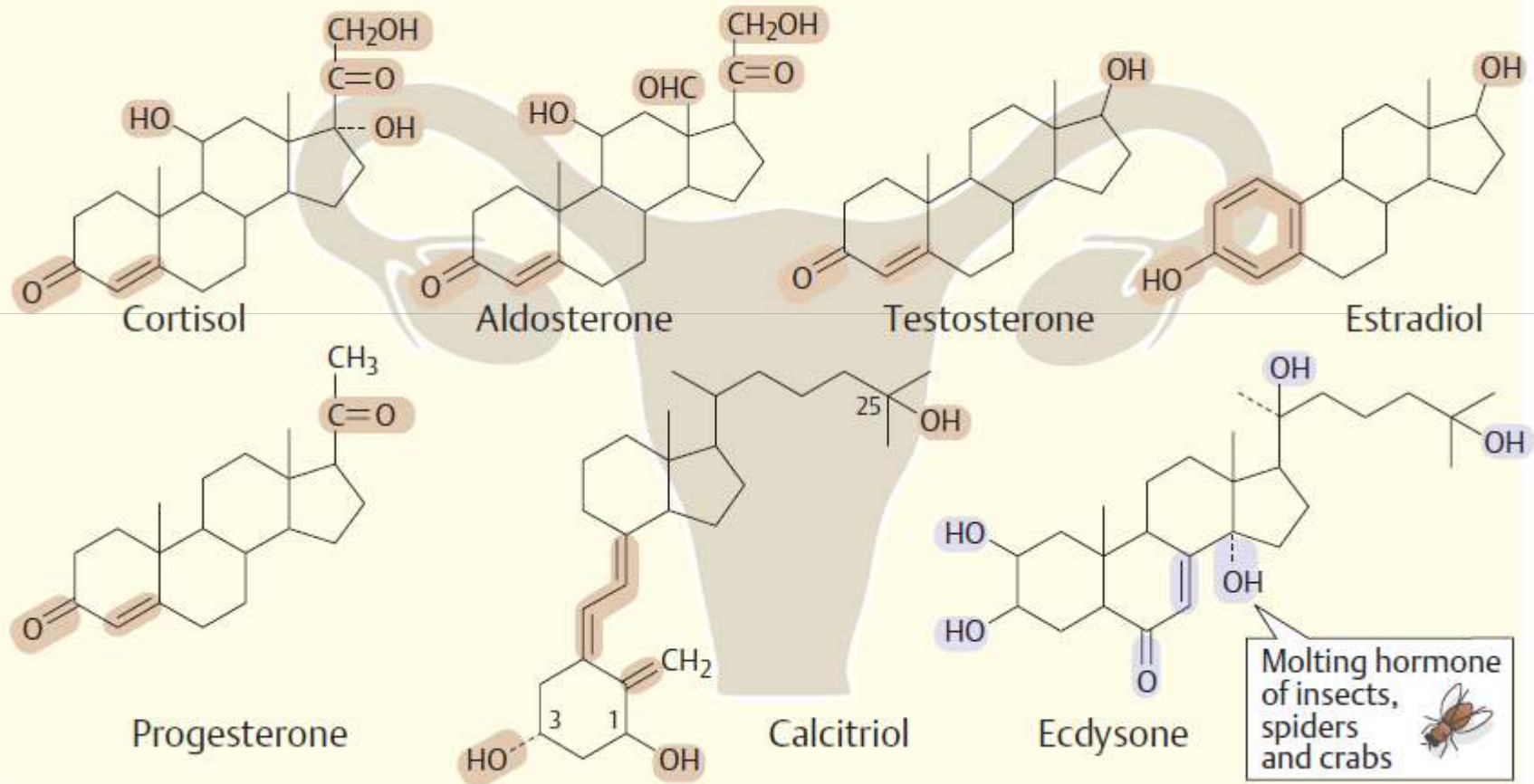


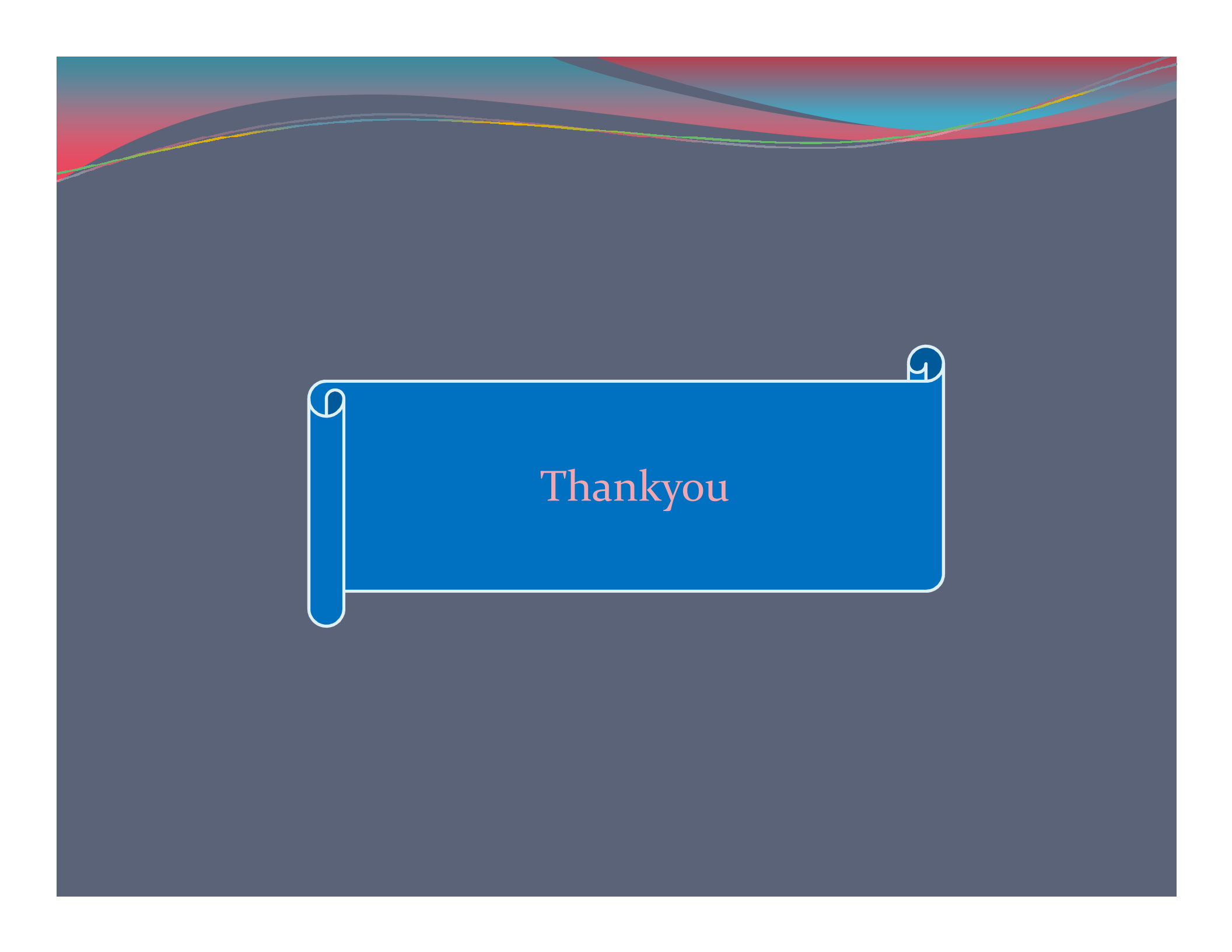
Stigmasterol



β -Sitosterol

C. Steroid hormones





Thankyou