- Starch: A polymer of **glucose molecules**
  - Stored by **plants** as granules → accessed via hydrolysis
- Glycogen: A highly **branched** polymer of **glucose**
  - Stored my **animals,** mainly in the liver and muscle cells
  - Hydrolysis of glycogen releases glucose, however cannot system animal for long periods of time

Structural Polysaccharides

- Cellulose: A **linear polymer** of **glucose**
  - Found in **plant cell walls**
- Chitin: A polymer of glucose with **nitrogen groups.**
  - Found in the **exoskeletons** of arthropods (insects, spiders, etc.)

Macromolecules – Lipids

LO3: Briefly describe the general structural features of lipids

- Triacylglycerol (TAG): **Three fatty acid** molecules join to **glycerol** by an **ester bond**
- Fatty acids can vary in length and in the number/position of double bonds
- Saturated fatty acids: **NO DOUBLE BOND** between carbons in their hydrocarbon chain (i.e. **butter)**
- Unsaturated fatty acids: **DOUBLE BOND** between carbons, causing **kinks** (i.e. oleic acid)

LO4: List some examples of members belonging to lipids

Phospholipids

- Essential to cells – make up the **cell membrane**
- Consists of a **hydrophilic (polar) head** group and **two hydrophobic (non-polar) tails**
- Similar structure to TAG, but **a phosphate group and polar (choline)** group replace one fatty acid chain

Steroids

- Carbon skeleton consists of **four fused rings**
- **Cholesterol** is a steroid found in **animal cell membranes**

LO5: Describe some key functions of these members of lipids

- Energy storage and transport: **Fats** (triacylglycerols or TAGs)
- Structure: **Phospholipids,** sterols
- Chemical Messengers: **Steroids** (e.g. cholesterol found in membranes, glycolipids)
- Coverings: waxes

Macromolecules – Proteins

LO3: Briefly describe the general structural features of proteins

- Proteins are **polymers of** amino acid monomers → linked by peptide bonds → polypeptide → **folded** into a **specific 3D** structure (determines the function)
- Peptide bond is formed by a **dehydration reaction** between **carboxyl group** of one amino acid and the **amino group of the next**
- **20** different amino acids used to build thousands of proteins

Protein Structure

- Primary Structure: A protein's unique **sequence of amino acids**
- Secondary Structure: The **conformation** adopted by **local** regions of the polypeptide chain
  - **H-bonds** from C=O and N-H provide stability between atoms of the polypeptide backbone
  - Alpha helix: Delicate **coil** held together by **H-bonds**
  - Beta pleated sheet: One continuous peptide with shows direction (arrows)
    - Anti-parallel (turns)

        - Parallel (loops)
- Tertiary Structure: Overall shape of the protein
    - 3-D shape is stabilized by **interactions between side chains**
        - **Hydrophobic** interactions**, H-Bonds, Ionic** or electrostatic bonds
    - Fibrous 3D protein structures: Long, extended and rod-like
        - Collagen, fibroin, keratin, fibrin
        - Are **soluble** in water
        - Mostly **alpha**-helices
    - Globular protein structures
        - **Complex**, compact and fold back on themselves (e.g. hemoglobin)
        - Can contain alpha-helices and beta-sheets
        - **Hydrophobic** core and **hydrophilic** surface
- Quaternary Structure: Overall shape of the protein
    - Polypeptide chains can assemble into multi-subunit structures → in most cases, they are held together by **non-covalent** bonds

DENATURATION

- Denaturation: Conditions such as heat/pH disrupt the secondary/tertiary structure of protein and it loses its function → unwind the long polypeptide chain

LO4: LIST SOME EXAMPLES OF MEMBERS BELONGING TO PROTEINS

- E.g. **hemoglobin**
    - 4 hemoglobin molecules interacting and joining together to carry oxygen in bloodstream
- E.g. **Collagen**
    - Fibrous protein with 3 identical helical polypeptides
    - Connective tissue in skin, bones, tendons, ligaments

LO5: DESCRIBE SOME KEY FUNCTIONS OF THESE MEMBERS OF PROTEINS

PROTEIN	FUNCTION
Structural	Support – i.e. **keratin** is the protein of hairs, feathers, and skin. **Collagen** provides elastic framework
Transport	Transport of substances – i.e. **hemoglobin** transports oxygen from lungs to body
Hormonal	Coordination of organism's activities – i.e. **insulin** regulates blood-sugar conc.
Defense	Protection against disease – i.e. **antibodies** destroy viruses and bacteria

Macromolecules – Nucleic Acids

LO3: BRIEFLY DESCRIBE THE GENERAL STRUCTURAL FEATURES OF NUCLEIC ACIDS

- Repeating **sugar-phosphate** units
- Nitrogenous bases A, T, C, G (4 building blocks) where A-T and G-C
    - Purine: double ring
    - Pyrimidine: single ring
- Deoxyribose sugar in DNA (Deoxyribonucleic acid), ribose sugar in RNA (ribonucleic acid)
- Both the sugars are **pentoses (5 carbons)**
- A phosphate group is added to the **5'** carbon of the sugar and the **base** is added to the **1'** carbon

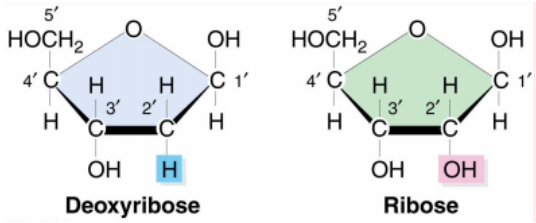
LO4: LIST SOME EXAMPLES OF MEMBERS BELONGING TO NUCLEIC ACIDS

DNA

- Contains **thymine** (not Uracil)
- Sugar = **deoxyribose**
- **Double-stranded**

RNA

- Contains **Uracil** instead of thymine
- Sugar = **ribose**
- **Single-stranded**
- **H-bonding** between bases directs base pairing
  - **TWO** H-Bonds between A and T
  - **THREE** H-Bonds between G and C (more stable)
- DNA strands in a double-helix are anti-parallel
  - Strands are orientated in opposite directions (**complementary**), and have **polarity**
  - Sequence is always written from **5' to 3'**



LO5: DESCRIBE SOME KEY FUNCTIONS OF THESE MEMBERS OF PROTEINS

- DNA is the primary form of genetic material stores **hereditary information**
- RNA functions:
  - mRNA – interacts with ribosomes to ensure a specific protein is translated
  - tRNA – ensures a specific amino acid is incorporated into a protein by the ribosome
  - Other RNA is involved in the **regulation of gene expression**

DNA ORGANIZATION: CHROMOSOMES

- DNA is organized into **chromosome,** where each chromosome is a **single DNA molecule**
- Chromatin: complex of DNA and proteins that form chromosomes in the nucleus

Cell Integrity

LO1: DESCRIBE THE STRUCTURE OF CELL MEMBRANES AND THEIR FUNCTION IN CELL INTEGRITY

- Membranes are **selectively permeable**, boundary between cell and surroundings, controlling traffic
  - 1935, Davson-Danielli Model: Protein are components of plasma membrane,
  - 1972, Singer-Nicolson *Fluid Mosaic Model*: Proteins are embedded in the lipid bilayer

Fluid Mosaic Model

- Peripheral protein: help the cytoskeleton attach to the lipid bilayer
- Integral membrane protein
- Cholesterol: help to make the lipid bilayer semi-solid
- Carbohydrates: recognition within cells of other cells
- The position of the protein domains relative to the membrane is fixed after the protein is inserted into the plasma membrane
- Sidedness: asymmetrical distribution of proteins, CHO, and lipids on two sides of membrane

LO2: DESCRIBE THE DIFFERENT COMPONENTS OF THE CELL MEMBRANE THAT ARE IMPORTANT IN MAINTAINING CELL INTEGRITY

- Lipids: **Phospholipids** and **cholesterol** (0-25%)
  - Fluids and other lipids help to make it semi-solid (Cholesterol) which are inserted between the phospholipids
- Proteins: **Peripheral** and **Integral**
  - Transmembrane: Proteins that span the membrane with different domains on each side of membrane
  - **Fluidity:** Rapid movement of lipids and proteins laterally in the plane of the membrane
    - Plasma proteins of mouse cell and human cell were labelled with different markers → cells fused → mixing of mouse and human proteins
    - Fluorescent Recover After Photo-bleaching (FRAP): Integral proteins tagged with fluorescence → Non-photobleached proteins move to the photobleached site
    - Lipid movement of proteins **slower in lipid rafts**
- Carbohydrates: **Glycolipids and Glycoproteins**
  - Addition of **sugar groups** allows the cells to be **recognized** by other cells/proteins