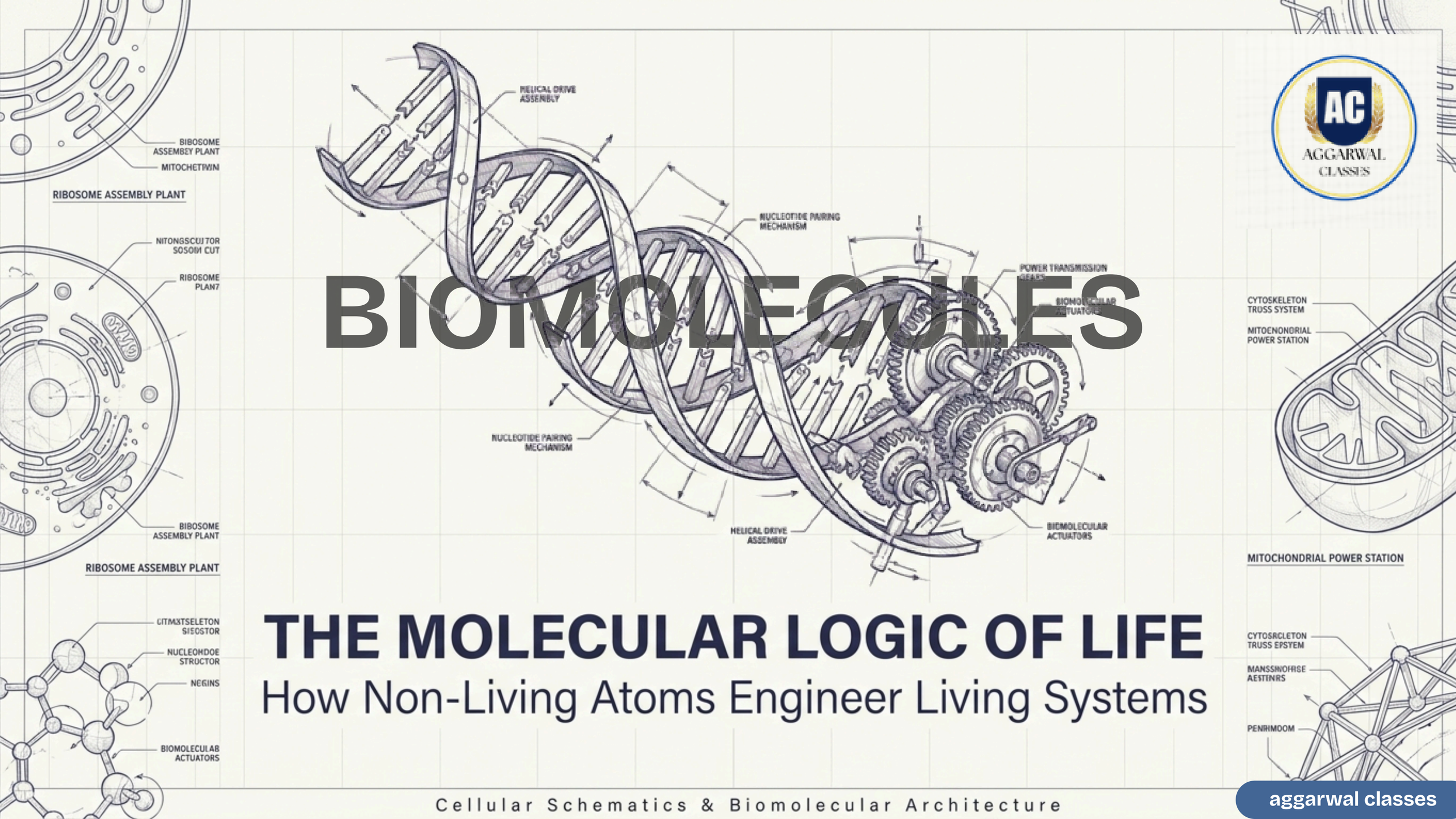


BIOMOLECULES

THE MOLECULAR LOGIC OF LIFE

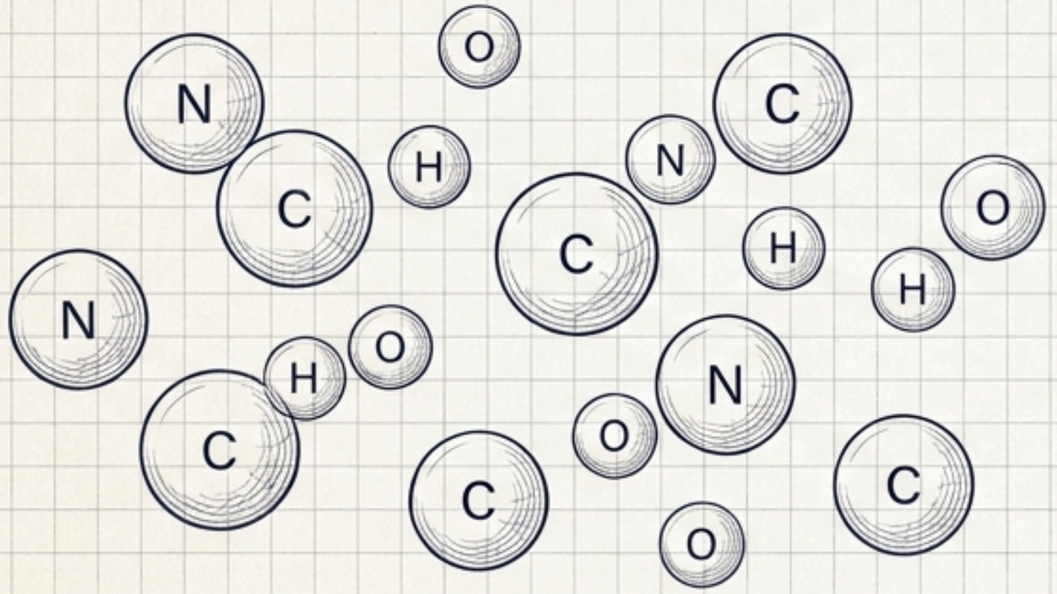
How Non-Living Atoms Engineer Living Systems

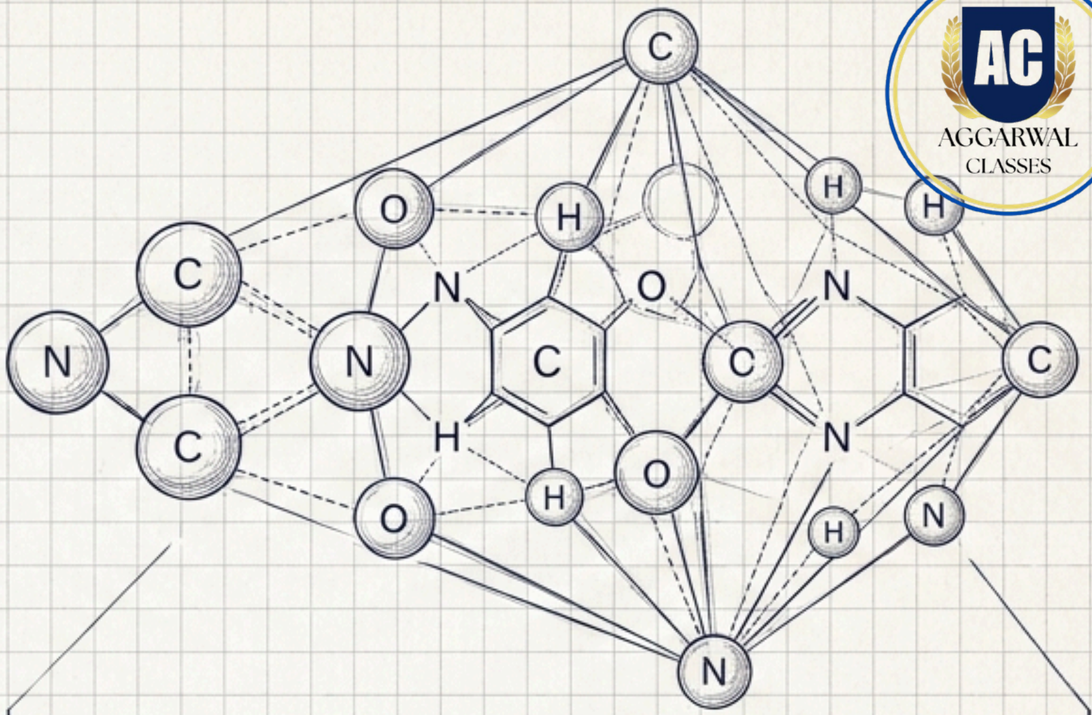
Cellular Schematics & Biomolecular Architecture

aggarwal classes

The Biochemical Paradox

"It is the harmonious and synchronous progress of chemical reactions in body which leads to life."





Fuel & Architecture	Dynamic Machinery	The Blueprints	System Regulators
Carbohydrates	Proteins	Nucleic Acids	Enzymes, Vitamins, & Hormones

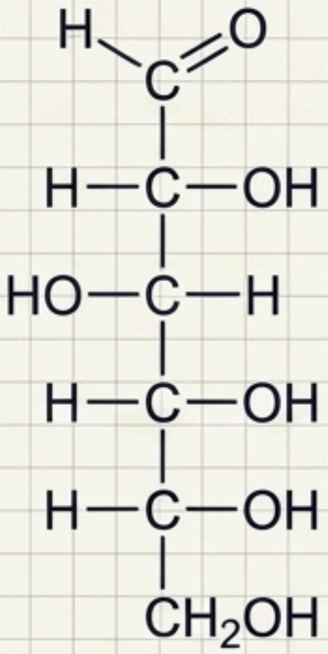
Carbohydrates: The Energy & Architecture Matrix

	Hydrolysis Yield	Taste/Solubility	Reducing Nature	Biological Role
Monosaccharides	Cannot be hydrolysed	Sweet / Water-soluble	All reduce Tollens'/Fehling's	Immediate metabolic fuel (e.g., Glucose, Fructose)
Oligosaccharides	2–10 monosaccharide units	Sweet / Water-soluble	Varies (Sucrose is non-reducing; Maltose/Lactose are reducing)	Transportable energy (e.g., Sucrose, Maltose)
Polysaccharides	100s–1000s of units	Non-sugars / Insoluble	Non-reducing	Structural framework (Cellulose) & Long-term storage (Starch, Glycogen)

The Structural Evolution of Glucose

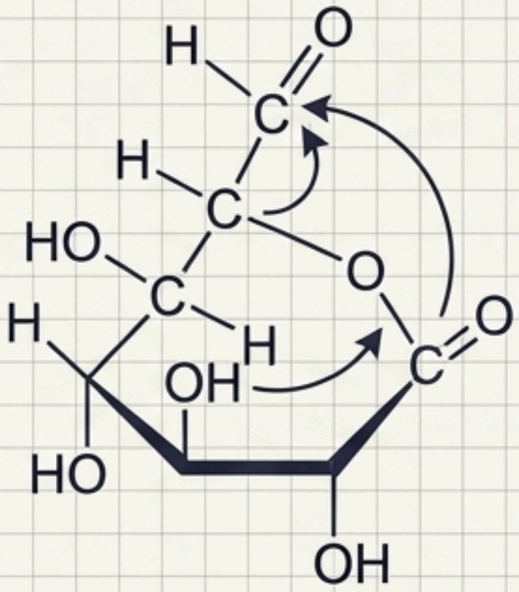
AGGARWAL CLASSES

Step 1: The Linear Chain



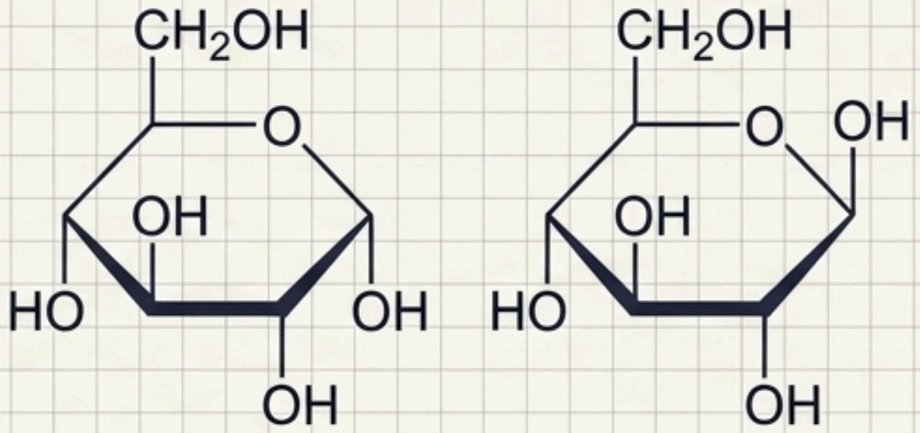
Aldohexose ($C_6H_{12}O_6$). Prolonged heating with HI yields n-hexane, proving a straight carbon chain.

Step 2: The Cyclisation Reaction



This internal reaction explains why glucose does not give Schiff's test!

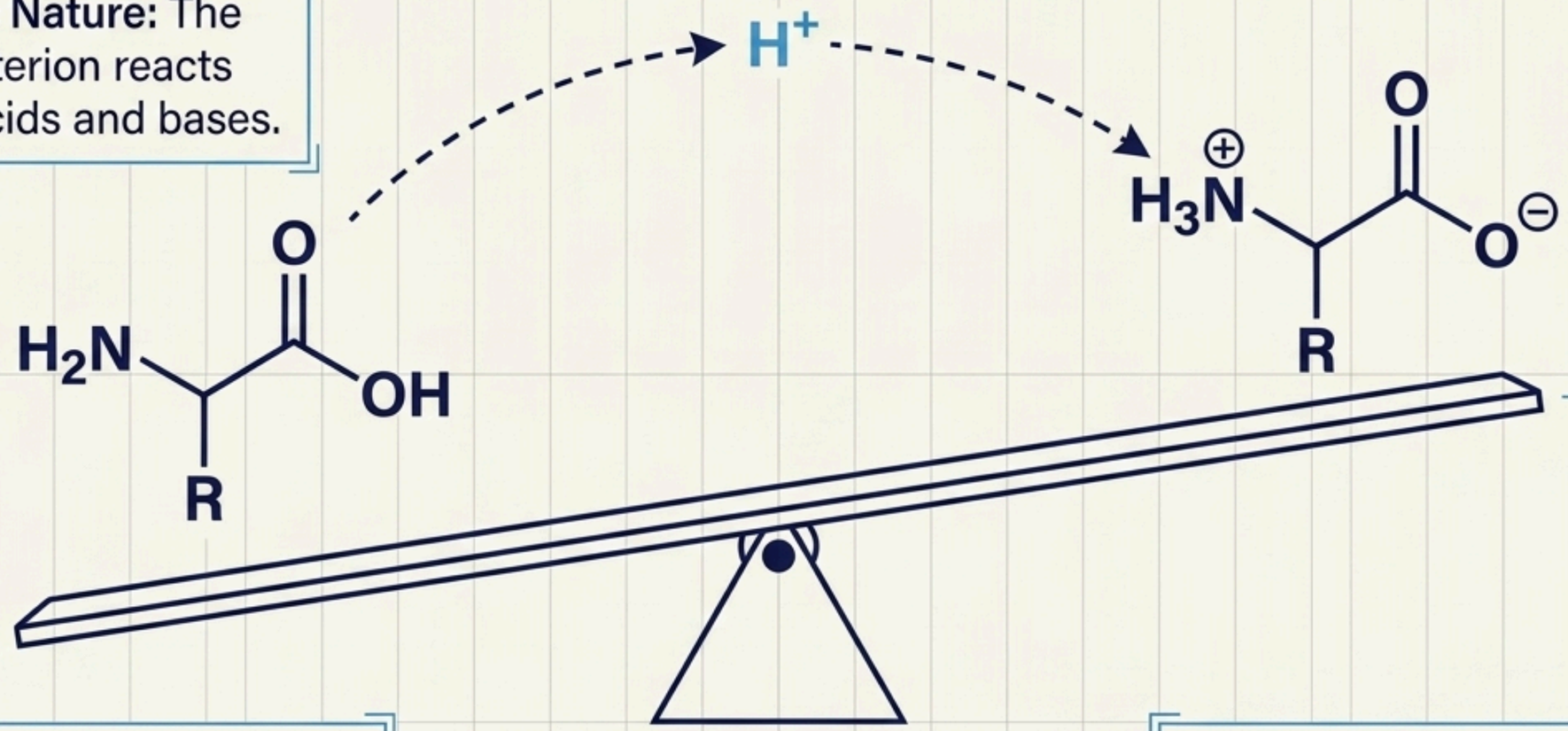
Step 3: The 3D Haworth Projection



The Anomeric Carbon: Alpha and Beta isomers differ only in the configuration of the hydroxyl group at C1.

Amino Acids & The Zwitterion Seesaw

Amphoteric Nature: The dipolar zwitterion reacts with both acids and bases.



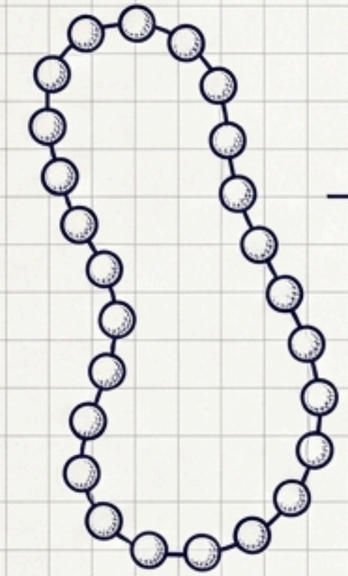
Electrical Neutrality

Chirality: All naturally occurring alpha-amino acids (except glycine) are optically active.

Configuration: Most natural amino acids possess L-configuration (-NH2 placed on the left).

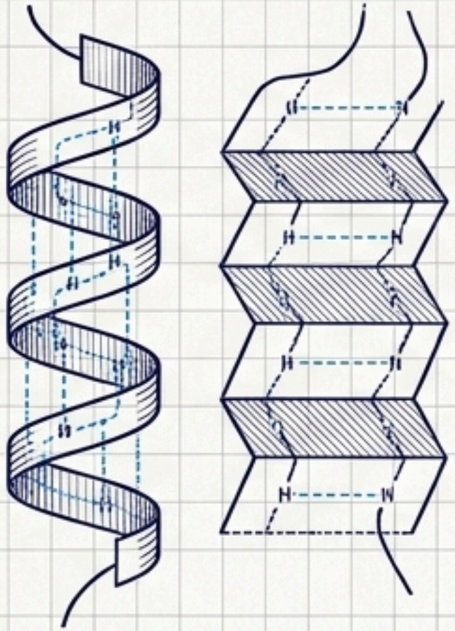
Progressive Protein Architecture

Zoom 1: Primary (1°)



The precise sequence of amino acids linked by peptide bonds.

Zoom 2: Secondary (2°)

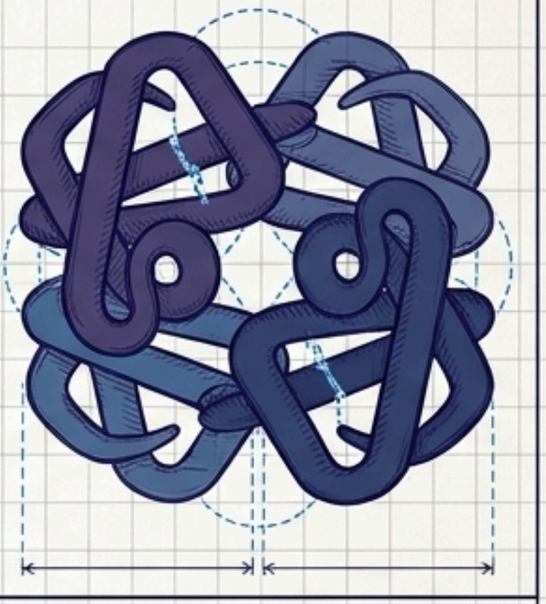


Stabilised by hydrogen bonds between >C=O and –NH– groups.

Zoom 3: Tertiary (3°)

Stabilised by disulphide linkages and van der Waals forces.

Zoom 4: Quaternary (4°)



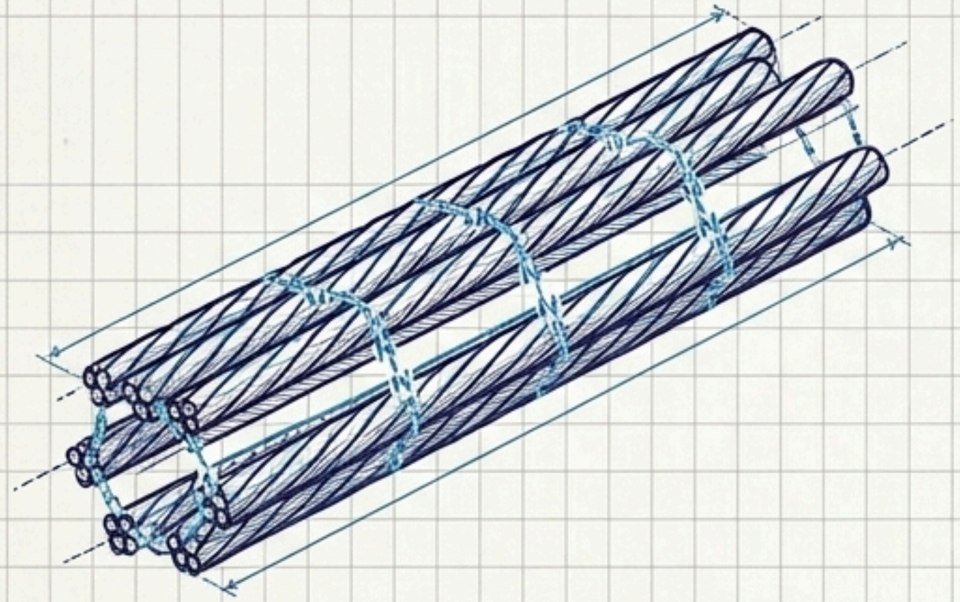
Spatial arrangement of multiple polypeptide sub-units (e.g., Haemoglobin).

Warning: Denaturation

Heat or pH changes destroy 2° and 3° structures (uncoiling the globule), but leave the 1° sequence intact (e.g., boiling an egg).

The Protein Shape Matrix

Fibrous Proteins



1 Shape
Parallel polypeptide chains forming fibre-like structures.

2 Forces
Held by hydrogen and disulphide bonds.

3 Solubility
Insoluble in water.

4 Biological Mandate
Structural integrity (e.g., Keratin in hair/wool/silk; Myosin in muscles).

Globular Proteins

1 Shape
Polypeptide chains coiled into spherical shapes.

2 Forces
Complex 3D folding (tertiary stabilisation).

3 Solubility
Soluble in water.

4 Biological Mandate
Dynamic biological functions (e.g., Insulin for regulation; Albumin for transport).

Mid-Deck Synthesis: The Universal Linkages

Nature builds its most complex nanostructures using a single, elegant trick:
Dehydration Synthesis—removing a water molecule to link monomers.

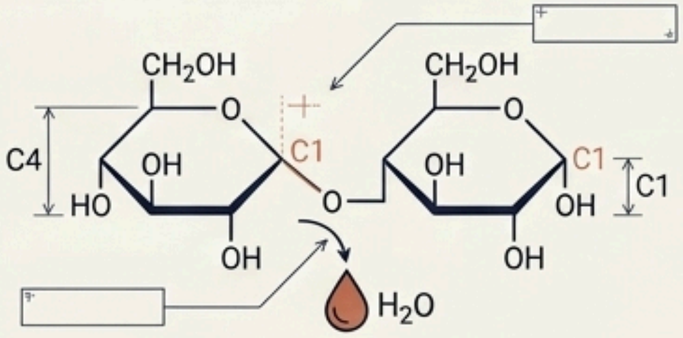
H_2O Ejected

H_2O Ejected

H_2O Ejected

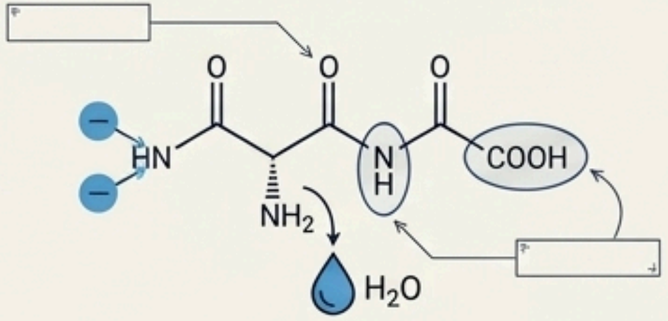
The Glycosidic Linkage

Monomers: Monosaccharides
Result: Carbohydrates
Mechanism: e.g., C1 of alpha-D-glucose linked to C4 of another.



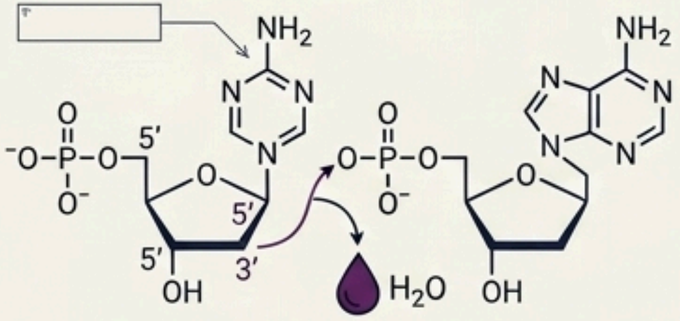
The Peptide Linkage

Monomers: Amino Acids
Result: Proteins
Mechanism: Amide formed between $-COOH$ and $-NH_2$.

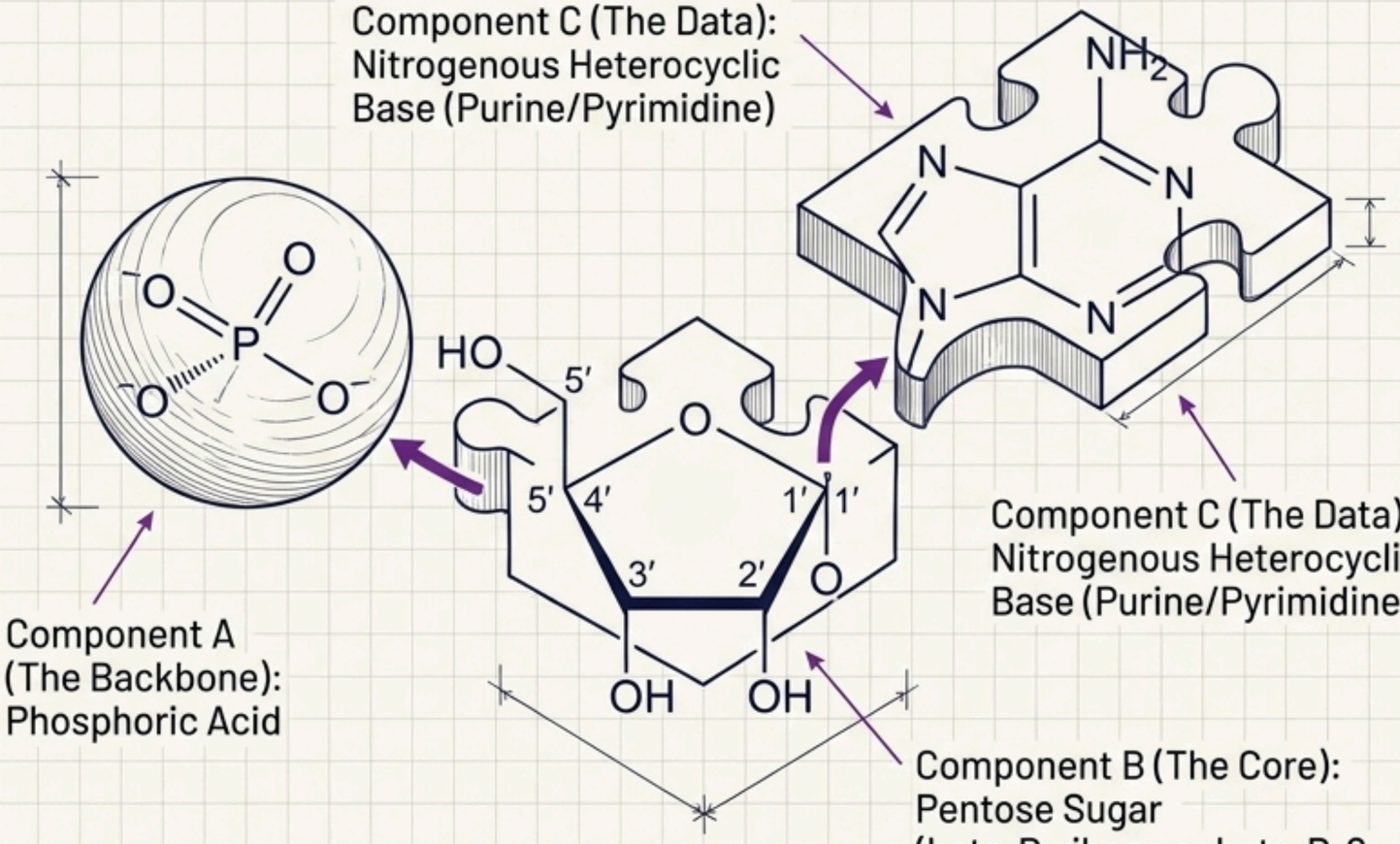


The Phosphodiester Linkage

Monomers: Nucleotides
Result: Nucleic Acids
Mechanism: Linkage between 5' and 3' carbon atoms of pentose sugars.



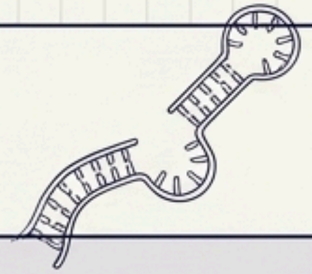
The Nucleotide Assembly Kit



The Assembly Process

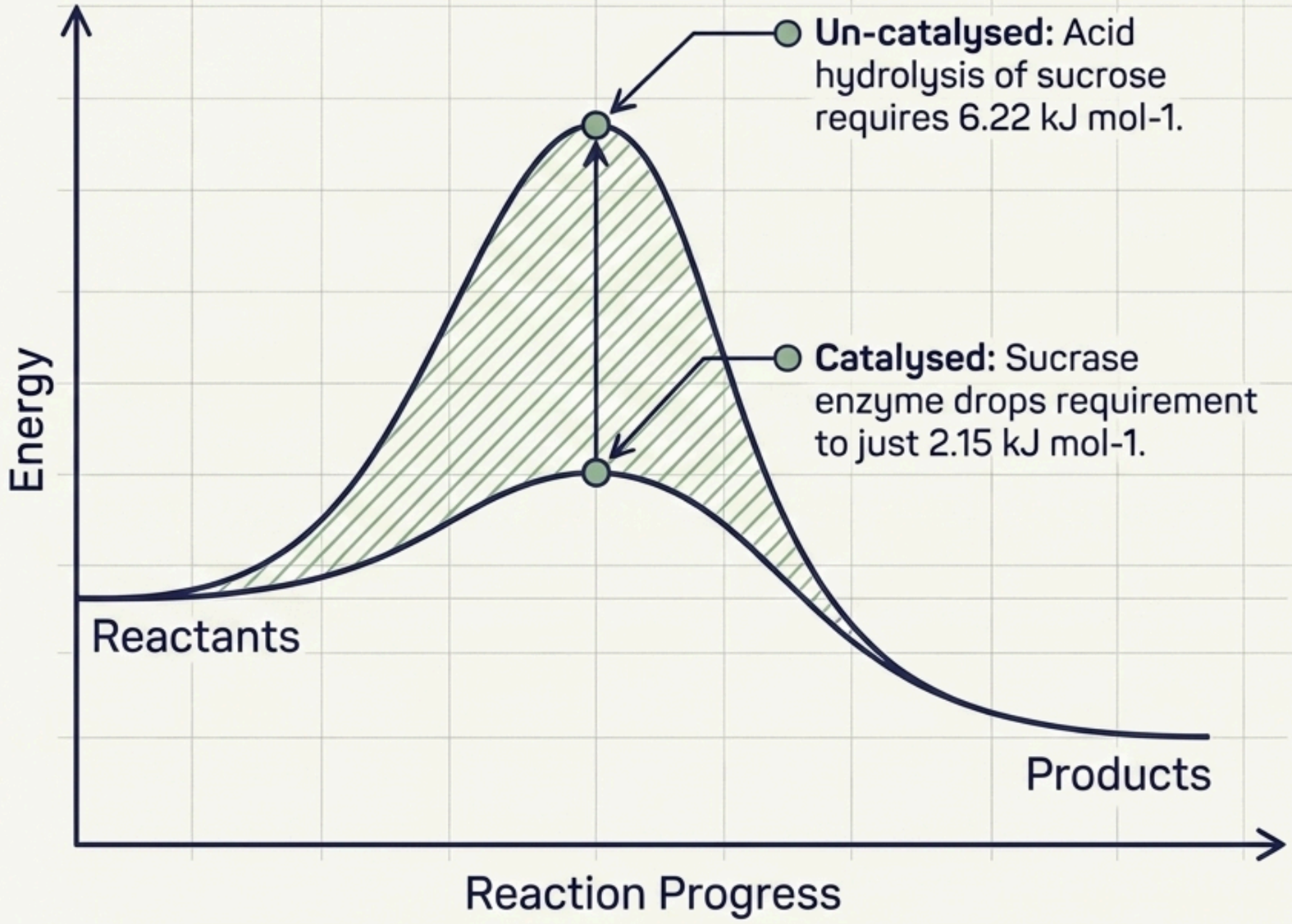
1. Base attaches to 1′ position of Sugar -> Nucleoside.
2. Phosphoric acid attaches to 5′ position of Nucleoside -> Nucleotide.
3. Nucleotides polymerise via phosphodiester linkages -> Polynucleotide (Nucleic Acid).

The Nucleic Acid Dichotomy

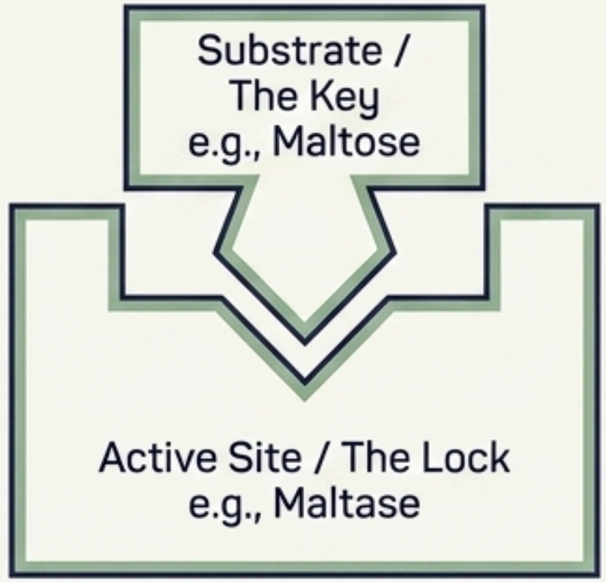


Dimension	Deoxyribonucleic Acid (DNA)	Ribonucleic Acid (RNA)
Sugar Identity	beta-D-2-deoxyribose	beta-D-ribose
Base Composition	Adenine, Guanine, Cytosine, Thymine (**T**)	Adenine, Guanine, Cytosine, Uracil (**U**)
Architecture	Double-stranded helix (Watson-Crick model). Strands are complementary.	Single-stranded helix (can fold back on itself).
Biological Mandate	The master archive of heredity (capable of self-duplication).	The active synthesiser of proteins (m-RNA, r-RNA, t-RNA).

Enzymes: The Precision Catalysts



Lock & Key Mechanism



Enzymes are highly specific globular proteins that drastically lower activation energy, operating seamlessly under mild bodily conditions.

The Vitamin Diagnostic Table

Water-Soluble Vitamins

Must be supplied regularly; excreted in urine.

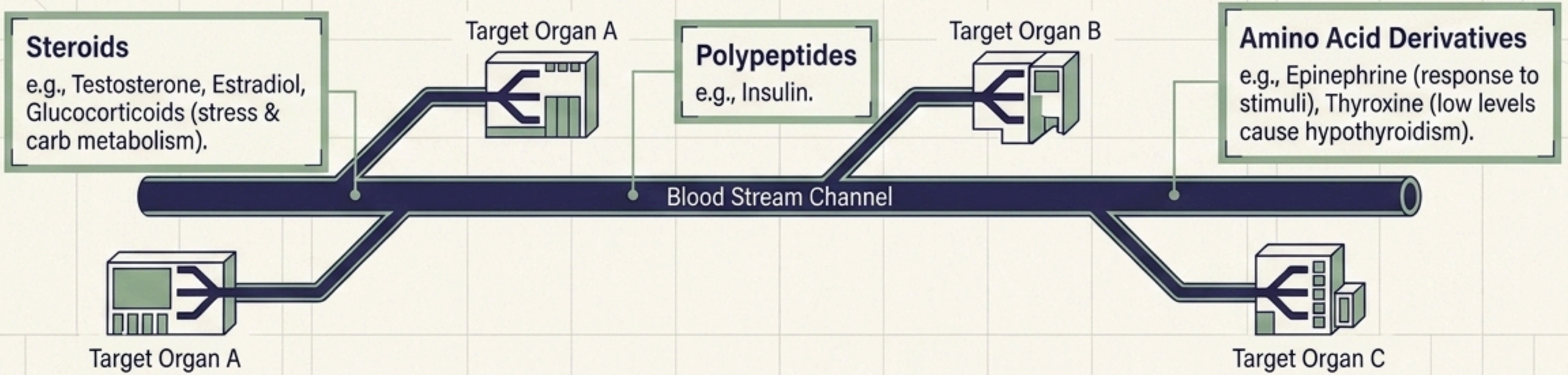
Vitamin	Source	Deficiency
Vitamin B1 (Thiamine)	Yeast/Milk	Beri beri (retarded growth)
Vitamin B2 (Riboflavin)	Milk/Eggwhite	Cheilosis (fissuring at corners of mouth)
Vitamin B12	Meat/Fish	Pernicious anaemia (Exceptional: can be stored in body)
Vitamin C (Ascorbic acid)	Citrus/Amla	Scurvy (bleeding gums)

Fat-Soluble Vitamins

Stored in liver and adipose tissues.

Vitamin	Source	Deficiency
Vitamin A	Fish liver oil/Carrots	Xerophthalmia, Night blindness
Vitamin D	Sunlight/Egg yolk	Rickets (bone deformities), Osteomalacia
Vitamin E	Vegetable/Wheat germ oils	Increased fragility of RBCs
Vitamin K	Green leafy vegetables	Increased blood clotting time

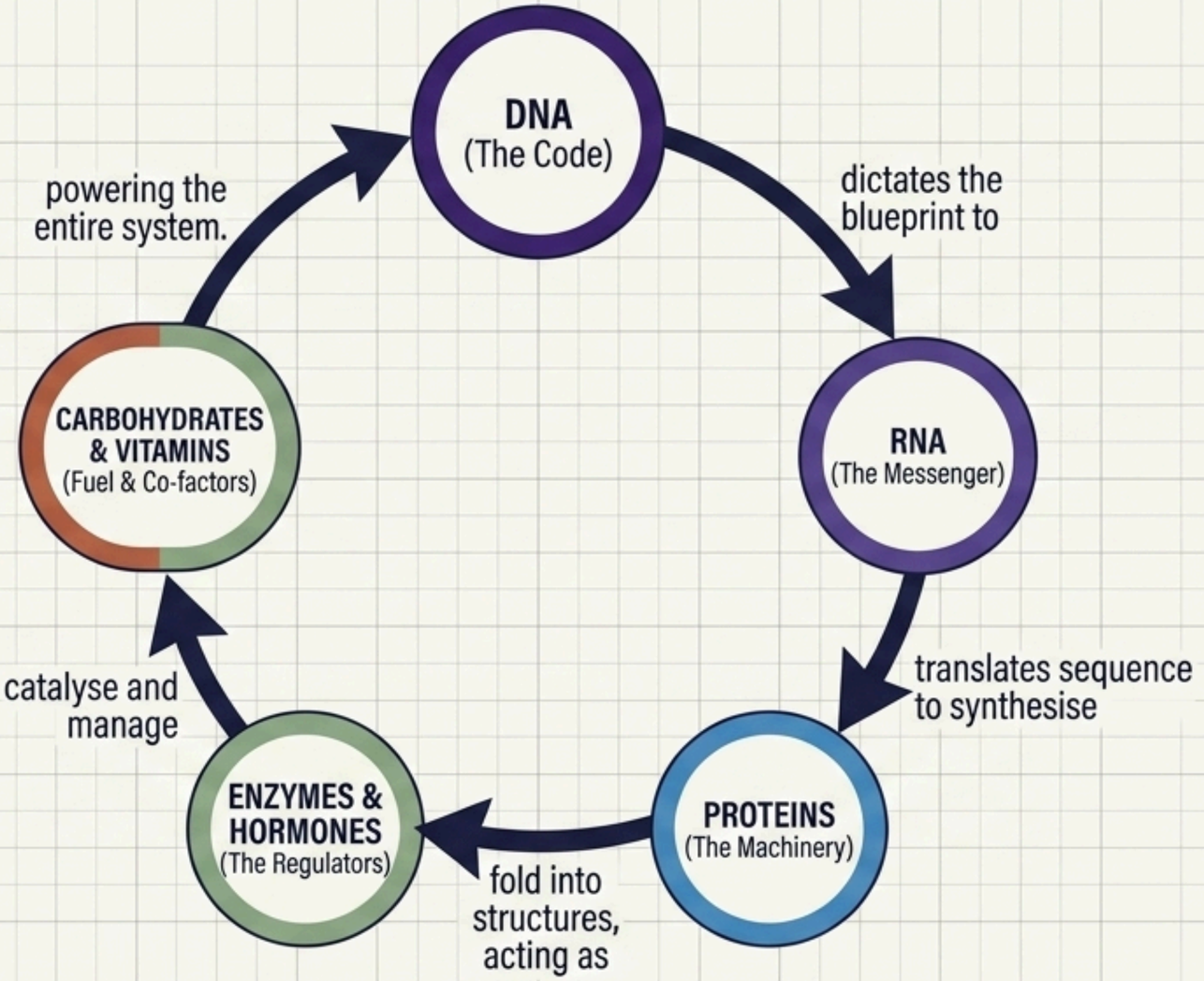
Hormones: The Intercellular Messengers



The Regulatory Seesaw

Maintaining the precise balance of biological activities.

Concluding Synthesis: The Harmonious Biosystem



It is the harmonious and synchronous progress of chemical reactions... which leads to life.

Life is Form Engineered from Function

From the precise chirality of a zwitterion to the immense 3D architecture of a quaternary protein, life is not magic magic—it is the flawless execution of biomolecular logic.

END OF SCHEMATICS