

Unit 1: Molecules, Diet, Transport and Health

WBI11 · Issue 2 · Topics 1-2 · water, carbohydrates, lipids, circulation, CVD,
membranes, proteins, DNA · sheets 1.1-1.12

From molecules to a working circulation

Unit 1 runs from a water molecule to a working circulation: every structure is asked what it is FOR.

Water is the transport solvent

The molecule

Slight negative end at oxygen, slight positive ends at hydrogen: the dipole that lets water cluster around any charged particle.

The consequence

Na^+ and Cl^- are pulled apart and surrounded: dissolved. Non-polar substances like lipids are excluded - which is exactly why membranes work.

Sugars join and split

Condensation 缩合: two monosaccharides lose one water molecule and bond

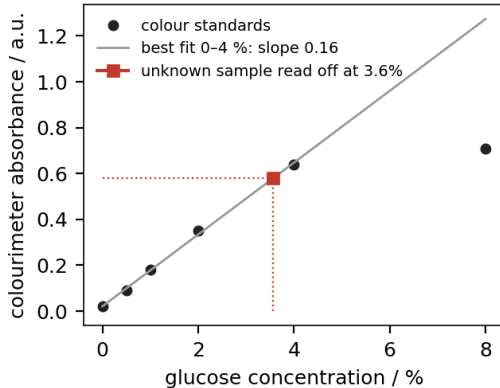


Glycosidic bond 糖苷键: the C-O-C link between the sugars



Hydrolysis 水解: digestive enzymes add water back and separate them

Estimate, do not just detect



Absorbance of Benedict colour standards against glucose concentration; the unknown reads off the straight section.

Lipids store more per gram

Type	Structure	State at room temperature
Saturated 饱和	no C=C, straight chains	solid - butter
Unsaturated 不饱和	one or more C=C, kinked chains	liquid - olive oil

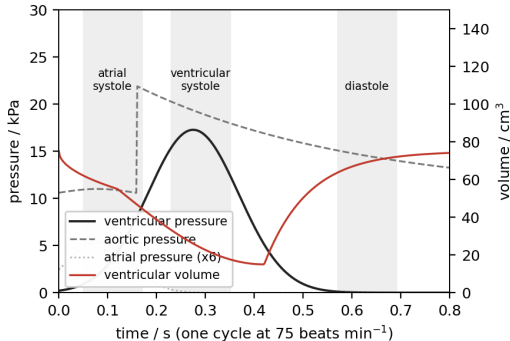
Diffusion cannot feed a big body

A heart and circulation exist because diffusion is too slow beyond a millimetre: pipes deliver, thin walls exchange.

Three vessels, three jobs

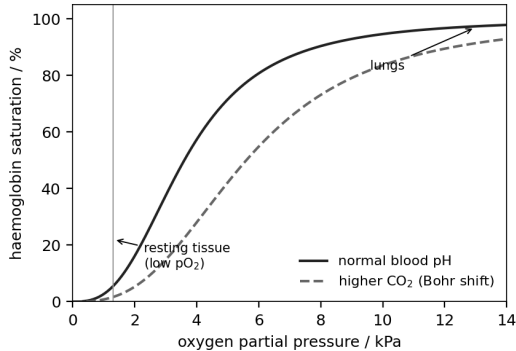
Vessel	Wall	Job
Artery 动脉	thick muscle + elastin, narrow lumen	carry the pulse at high pressure
Capillary 毛细血管	endothelium one cell thick	exchange: short path, big area
Vein 静脉	thin wall, wide lumen, valves	low-pressure return, no backflow

The cardiac cycle in three phases



Ventricular and aortic pressure with ventricular volume across one cardiac cycle; valves change state where the curves cross.

Haemoglobin loads, shifts and unloads



Sigmoid oxygen dissociation curve with the rightward Bohr shift at higher carbon dioxide.

Atheroma, clot, catastrophe

Damage 内皮损伤: smoking, hypertension, LDL cholesterol harm the endothelium

Plaque 斑块: inflammation and LDL deposition narrow and stiffen the artery

Clot 凝血: thromboplastin converts prothrombin to thrombin; fibrinogen becomes fibrin

Read a health study like an examiner

Your turn

Gum disease correlates with endothelial damage. List three checks before claiming causation.

- A. Who was sampled, how selected, how many?
- B. Were confounders like smoking, age, diet controlled?
- C. Is there a mechanism and a dose-response pattern?

Diet, cholesterol and the drug trade-off

- 1 **BMI** $74 \text{ kg} / 1.66 \text{ m squared} = 26.9$ - overweight band
- 2 **WHR** waist 84 / hip 98 = 0.86
- 3 **Statins** block a liver enzyme; cells take up LDL from blood; muscle and liver side-effects

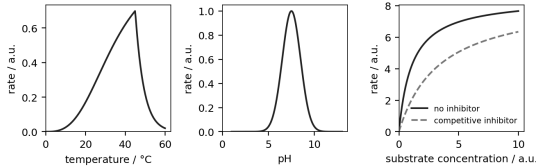
The fluid mosaic membrane

Fluid because the tails slide; mosaic because proteins of many shapes are scattered through it.

Four routes across a membrane

Route	Gradient	Protein	ATP
Diffusion 扩散	down	none	no
Facilitated 易化 扩散	down	channel or carrier	no
Active transport 主动运输	against	carrier pump	yes
Osmosis 渗透	water, down water potential	partially permeable membrane	no

Enzymes: shape is function



Rate curves for temperature, pH and substrate concentration, with and without a competitive inhibitor.

DNA copies itself semi-conservatively

Unzip 解旋: helicase breaks the hydrogen bonds between the strands

Template 模板: each old strand pairs with free nucleotides by complementary base pairing

Join 聚合: DNA polymerase links the nucleotides into a new strand

From gene to protein, and when it goes wrong

Substitution 替换

One base swapped: one amino acid changes - or none, because the code is degenerate. Often survivable.

Frameshift 移码

One base added or lost: every triplet after the mutation reads differently. Usually destroys the protein - cystic fibrosis is the model case.

Check yourself

Structure names its function: the sentence that answers every WBI11 question.