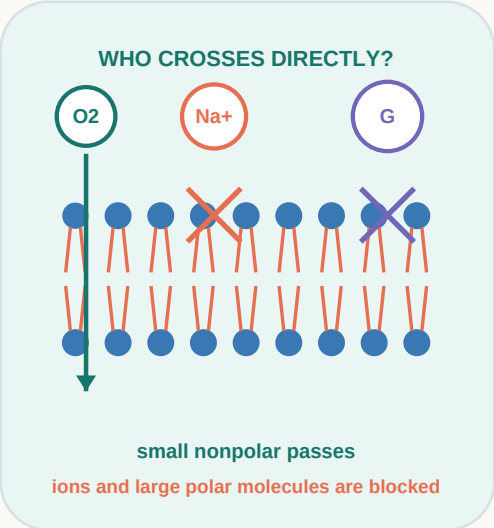
AP BIOLOGY | UNIT 2

# TOPIC 2.4

## Membrane Permeability

A substance's size, polarity, and charge determine how easily it crosses the phospholipid bilayer.




### THE CORE CAUSAL CHAIN

**PROPERTIES** → size + polarity + charge

**CORE** → hydrophobic barrier

**PERMEABILITY** → ease of crossing

**HOMEOSTASIS** → regulated exchange

### BY THE END, YOU SHOULD BE ABLE TO...

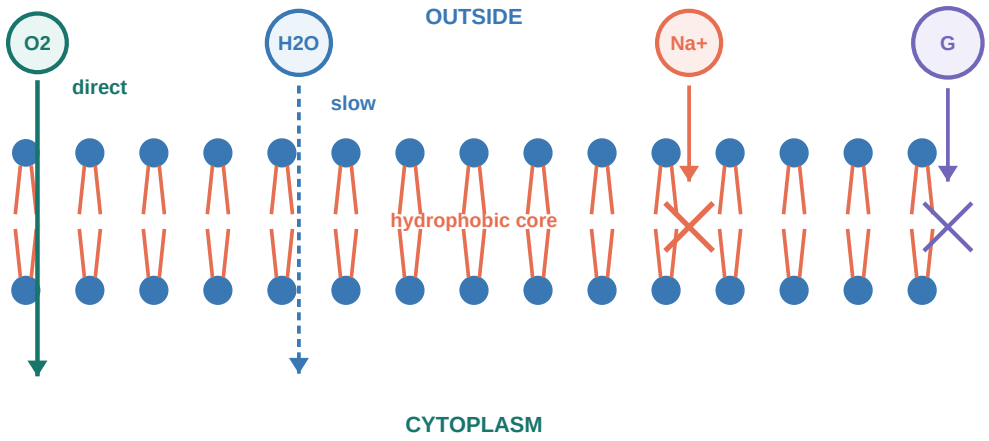
1. Rank substances by direct bilayer permeability.
2. Explain why ions and large polar molecules need proteins.
3. Separate permeability from concentration-gradient effects.

**BIG IDEA**

The hydrophobic membrane core is not equally permeable to every substance. Selectivity allows cells to regulate internal conditions.

# 1 What controls direct permeability?

Direct permeability depends on whether a substance can enter and move through the hydrophobic lipid interior.




## DIRECT PERMEABILITY RANKING

| | | | |
|---|---|---|---|
| HIGHEST | **SMALL NONPOLAR**<br>O2, CO2 | | Small and compatible with lipids. |
| LIMITED | **SMALL POLAR**<br>H2O | | Small, but polarity resists the core. |
| VERY LOW | **LARGE POLAR**<br>glucose, sucrose | | Large and poorly lipid-soluble. |
| VERY LOW | **IONS**<br>Na+, K+, Cl- | | Charge is strongly excluded by the core. |

## ASK THREE QUESTIONS

**1 SIZE**

Smaller is generally easier.

**2 POLARITY**

Nonpolar mixes with the lipid core.

**3 CHARGE**

Charged substances need a pathway.

**CORE RULE**

**The more charged, polar, or large a substance is, the less likely it is to cross the phospholipid bilayer directly.**

# 2 From permeability to homeostasis

Cells combine a selective lipid barrier with specific transport proteins to regulate internal conditions.

## ONE MEMBRANE, DIFFERENT ROUTES

### O2 DIRECT THROUGH BILAYER

Small and nonpolar, so it can enter the lipid core.

### H2O LIMITED DIRECT + AQUAPORINS

Small but polar; channels can greatly increase water flow.

### G SPECIFIC TRANSPORT PROTEIN

Glucose is large and polar, so the lipid core blocks it.

### Na+ CHANNEL OR PUMP

Charge prevents direct crossing through the hydrophobic core.

## DO NOT CONFUSE THESE

| CONCENTRATION GRADIENT | MEMBRANE PERMEABILITY |
| --- | --- |
| A difference in concentration that helps determine the direction and strength of net movement. | How easily the substance can cross. A gradient cannot remove the hydrophobic barrier to an ion. |

## INTERPRETING PERMEABILITY DATA

| RATE | CONTROLS | CLAIM |
| --- | --- | --- |
| faster crossing = greater permeability | same area, time, temperature, and gradient | connect the result to size, polarity, or charge |

**COMMON ERROR**

**A steep concentration gradient can increase net movement only if the substance has a way to cross the membrane.**