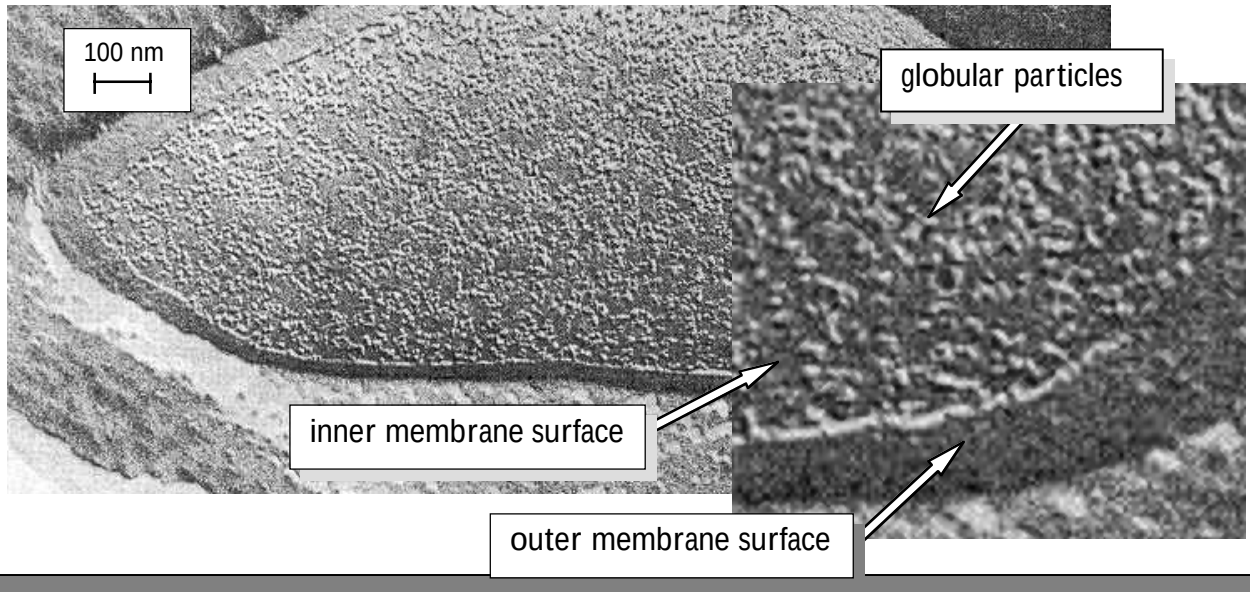
B THEORETICAL MODELS: CELL MEMBRANES

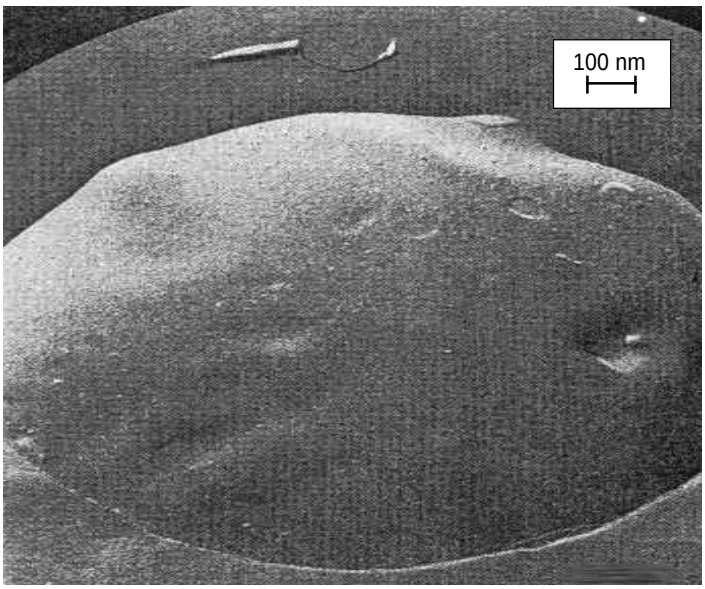
FREEZE FRACTURE ELECTRONMICROGRAPH EVIDENCE

In the freeze fracture technique, the sample is frozen and then cut with a microtome knife to split the cell. This exposes the membrane's layered structure showing the **outer and inner layers**.

This electron micrograph image shows a red blood cell treated in this way. Note the presence of **globular particles** on the **top surface of the inner membrane layer** which would be **within** the intact membrane.



The second picture shows a similarly treated cell that has first had **70% of the protein removed**. There are **very few of the globular structures** that appear in the membrane of the untreated cell.



Reprinted from Gomperts, BD (1977) *The plasma membrane: models for structure and function*. chapter 2, page 55, by permission of the publisher, Academic Press

B THEORETICAL MODELS: CELL MEMBRANES

NMR AND X-RAY DIFFRACTION EVIDENCE

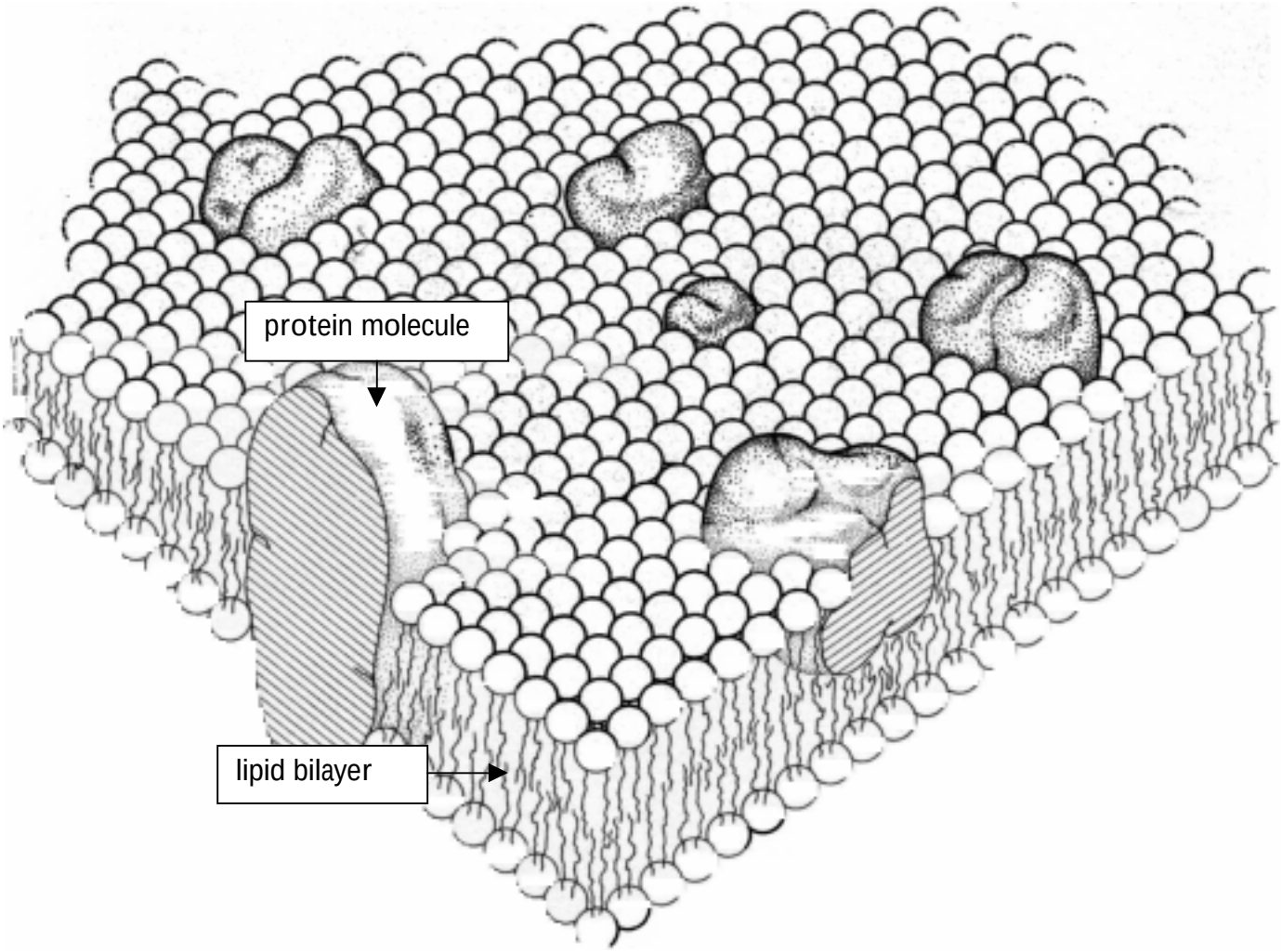
NMR stands for Nuclear Magnetic Resonance. By exposing the molecules of the membrane to a static and an oscillating magnetic field, scientists have been able to show that the **lipids** in the membrane, which have a characteristic magnetic 'spin', **move** over distances of up to 50 nm during the duration of the measurement (5 to 10 seconds).

X-ray diffraction has shown that, at higher temperatures, the hydrocarbon chains of the **lipids** give off diffraction patterns **similar** to those of **liquid** paraffins. However at low temperatures this movement is lost.

B THEORETICAL MODELS: CELL MEMBRANES

SINGER AND NICHOLSON MODEL

Singer and Nicholson's 'fluid mosaic model' (1972) was again a development of Danielli and Davson's model but with more significant differences than in the Robertson model.



The key differences are as follows.

The proteins **do not form a structural layer** holding the lipids in place so the **lipid component of the membrane is not rigid but fluid.**

The **proteins are not attached to the outside of the lipid layer but embedded within it**, in some cases extending through the thickness of the membrane.

B THEORETICAL MODELS: CELL MEMBRANES

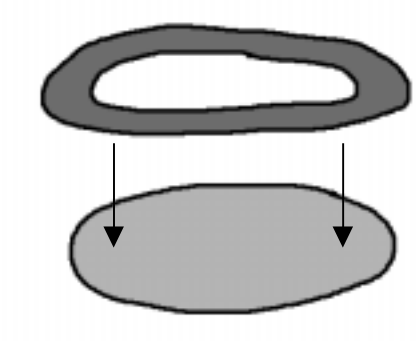
PLASTICINE MODEL

In pilot studies, student feedback suggested that a simple model was helpful in understanding the evidence presented on the freeze fracture sheet.

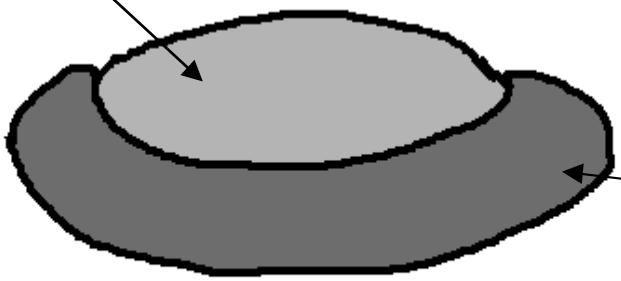
In freeze fracture preparation, the sample is frozen and then cut with a microtome knife in a way which exposes the interior of cell organelles.

In the electronmicrographs shown on sheet B3.1, the membrane has been fractured in a way which exposes the interior of the membrane bilayer.

The simple model described here helps to illustrate this.
Roll out a flattened doughnut of plasticine and superimpose it on a roughly circular sheet of a contrasting colour.



This surface represents the outer face of the inner layer of the membrane.



This surface represents the outer face of the upper layer of the membrane

Current membrane research

Studies of cell surface protein receptors in T-cells has shown a link between tumour necrosis factor (TNF), which attacks cancer cells, and the ageing process. (1999)

Work on molecules that bind with specific receptors on membranes is enabling new drugs to be developed. (2000)