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专业英语基础丛书

Advanced HUMAN BIOLOGY through diagrams

人体生物学专业英语基础（图示教程）

W R Pickering

上海外语教育出版社 外教社

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王维荣
李宁军　注释
夏冠军

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Advanced

HUMAN BIOLOGY

through diagrams

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出 版 前 言

1999年出版的《大学英语教学大纲(修订本)》明确提出，“学生在完成基础阶段的学习任务，达到四级或六级后，都必须修读专业英语”。这是大纲修订组在对用人单位进行了广泛调查的基础上，结合英语学习的规律，对大学英语教学提出的新要求。因此，目前国内急需一套内容全面、语言地道的专业英语教材和读物。

《牛津专业英语基础丛书》原版由牛津大学提供，包括物理学、化学、生物学、人体生物学、商务、地理学、心理学、经济学等8种。该丛书原为英国A-level(相当于大学预科)考试的复习用书。书中以图表的形式，归纳整理了学科的主要知识。其中不仅包括常用的专业词汇和句型，还有连贯的短文，十分适合作为大学生专业英语的自学教材。

为了方便读者使用，本社约请了复旦大学、华东理工大学、华东师范大学、上海理工大学、上海财经大学等高校有关专业既有专业特长，又精通英语的教授对该丛书作了详细的注释，并给难读的单词加注了音标。

本丛书既能帮助大学生复习巩固专业知识，又能提高专业英语水平，还可以作为有关专业的人员提高专业阅读和翻译能力的教材或读物。

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THE BIOLOGY OF ECOSYSTEMS

生态系统的生物学

LIFE PROCESSES

生命过程

Plant and animal cells

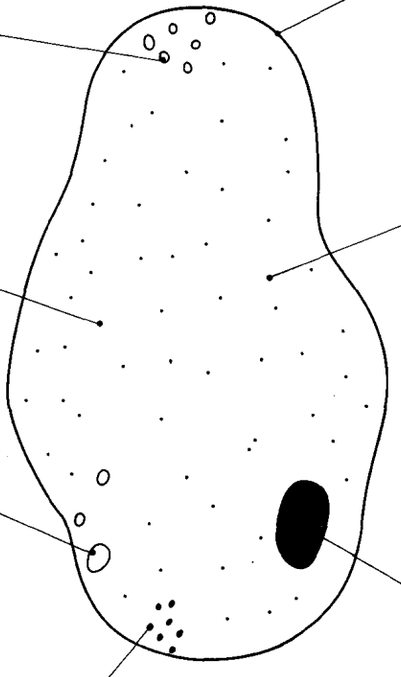
ANIMAL CELL FEATURES often relate to heterotrophic nutrition and high rates of metabolic activity.

Secretory vesicles containing cell products such as hormones or enzymes are much more common in animal cells.

Cytoplasm of animal cells is often denser, with many more organelles and dissolved substances.

Vacuoles are small and temporary. They can be involved with digestion (e.g. in phagocytes) or with excretion (contractile vacuoles may remove excess water).

Glycogen is the storage form of carbohydrates.

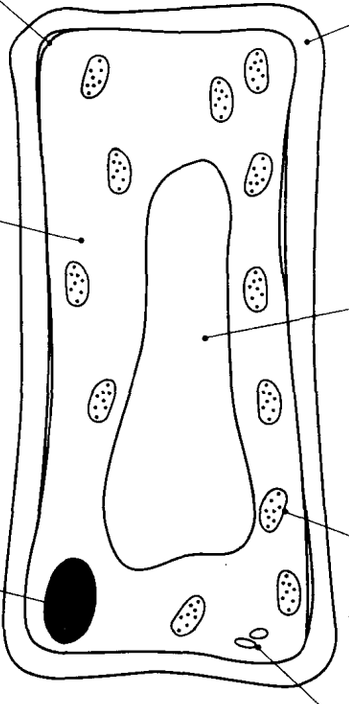


PLANT AND ANIMAL CELLS HAVE COMMON FEATURES which relate to maintaining the characteristics of life.

Cell membrane which surrounds the cytoplasm. It controls the **entry and exit** of dissolved substances and is therefore responsible for separating the cells contents from its surroundings.

Cytoplasm contains water, dissolved substances such as amino acids and sugars, and supports the various organelles (for example, mitochondria, ribosomes). It is within the cytoplasm and organelles that the various metabolic reactions needed to sustain life take place (for example, respiration).

Nucleus contains the genetic material (**DNA** which makes up **genes** or the **chromosomes**) which carries the coded instructions controlling the activities and characteristics of the cell. The chromosomes only become visible during cell division.



PLANT CELL FEATURES often relate to autotrophic nutrition.

Cellulose cell wall provides structural support (pressure of cell contents leads to **turgidity**) and protects against damage caused by osmotic intake of water. It is **freely permeable to water and dissolved substances**.

Large permanent vacuole contains water necessary to provide turgor pressure and may be store for ions and molecules.

Chloroplasts contain the pigment **chlorophyll** (light absorption) and the **enzymes** necessary for the production of glucose by photosynthesis.

Starch (in the cytoplasm or the chloroplasts) is the storage form of carbohydrate.

The absence of the cellulose cell wall means that animals cells may be **very irregular in shape** and the limit to the amount of cytoplasm which can be controlled by the nucleus means that animal cells may be **quite small** - about 25 µm diameter.

The presence of the cellulose cell wall means that plant cells tend to be **regular in shape** and the presence of the vacuole means that plant cells may be **quite large** - often 60 µm (or 0.06 mm) in diameter.

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Transmission electron microscope

Cathode: metal electrode (commonly platinum) which emits high velocity electron beam. Electrons are negatively charged particles (e^-).

Anode: positively charged electrode at potential of 50 kV with respect to cathode - accelerates the electron beam.

Condenser: electromagnetic lens which focuses the electron beam on to the specimen.

Air lock/specimen port: allows the introduction of the specimen into the microscope without the loss of vacuum.

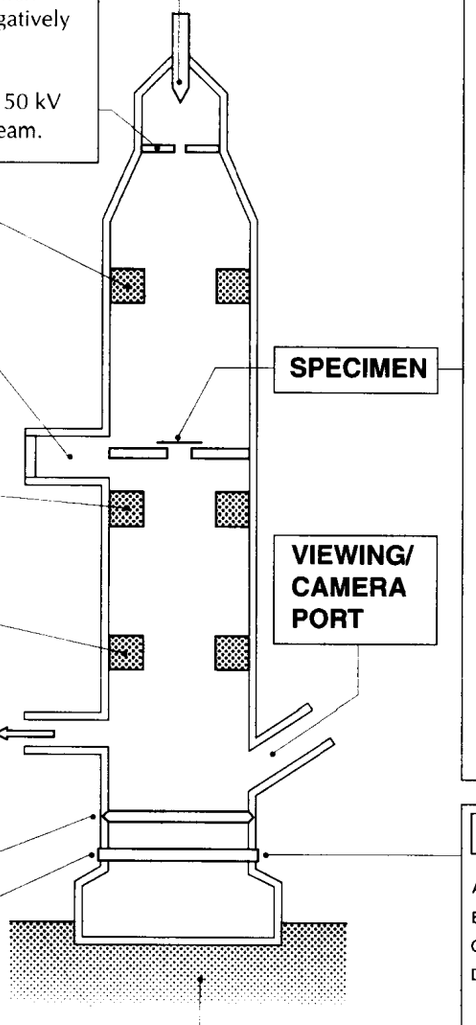
Objective: electromagnetic lens which focuses and magnifies (depending on applied voltage) the first image.

Projector: further magnification by selection of region of image to be viewed.

To vacuum pump: creation of vacuum to minimize electron scattering and any heating due to electron/air molecule collision.

Fluorescent, swing out, screen: coated with electron sensitive compounds - necessary since deflected electron beam (the image) cannot be viewed directly.

Photographic plate: allows a black and white permanent record of the image to be made. Printing may offer further magnification.



Concrete base: stable support which minimizes vibration and thus eliminates unwanted deflection of electron beam.

Sample is

Fixed: to avoid deformation of all cell components. Use small sample (rapid penetration) and immerse in ***glutaraldehyde*** or ***glutaraldehyde/osmic acid.***

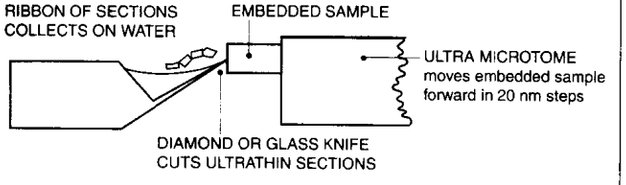
Dehydrated: to prepare material for infiltration by embedding or infiltration medium which is not miscible with water. Dehydration should be gradual to preserve fine detail, using a series of progressively increasing concentrations of ***ethanol*** or ***propanone.***

Cleared: alcohol or propanone may be immiscible with embedding agents and so is replaced with a clearing agent (commonly ***xylol***) which is miscible and also makes the material transparent.

Embedded: ready for ***plastic*** or ***resin*** is used to support the material so that it is not distorted during sectioning.

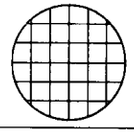
Sectioning

The material must be cut into ***ultrathin sections*** (20-100 nm thick) since the electron beam has very low penetrating power.



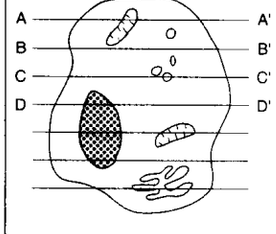
Staining: biological structures are transparent, or nearly so, to electrons. To increase electron beam deflection (i.e. contrast between different structures) sections are treated with ***solutions of heavy metal salts*** such as ***uranyl*** or ***lead acetate.***

Mounting:



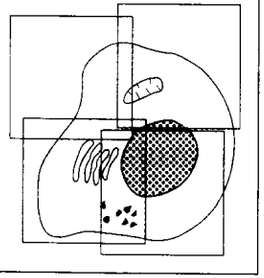
sections are supported on a small copper grid (~3 mm diameter). The electron beam may pass through the gaps in the grid (a glass slide would not permit transmission of electron beam).

IMAGE INTERPRETATION



A number of ultrathin sections, e.g. A-A', B-B', must be examined to provide a true three-dimensional representation of the sample.

High magnification means that several photographs may be necessary to give a composite image of the specimen.



Scanning electron microscope

Cathode: Metal electrode (commonly platinum) which emits high velocity electron beam. Electrons are negatively charged particles (e^-)

Anode: positively charged electrode at potential of 50 kV with respect to cathode – accelerates the electron beam.

Condenser: Electromagnetic lens which focuses the electron beam onto the specimen.

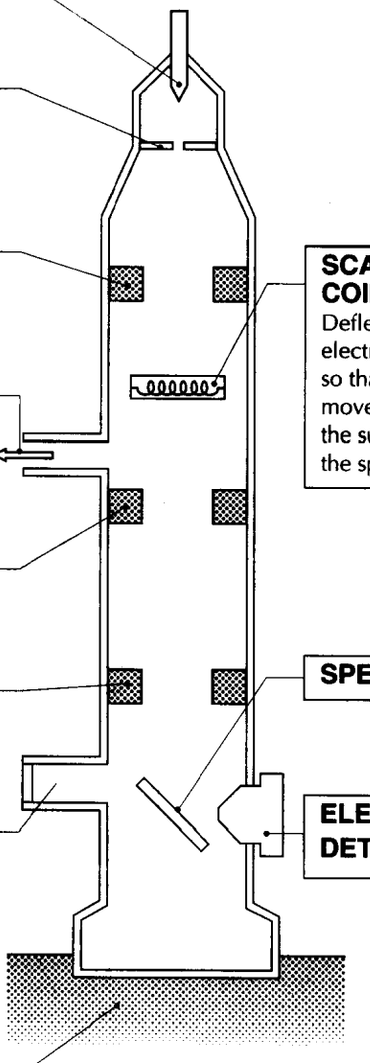
To Vacuum Pump: Creation of vacuum to minimise electron scattering and any heating due to electron/air molecule collision.

Second Condenser: Further focusing of beam onto specimen.

Objective: Electromagnetic lens which focuses and magnifies (depending on applied voltage) the first image.

Air Lock/Specimen Port: Allows the introduction of the specimen into the microscope without the loss of vacuum.

Concrete Base: Stable support which minimises vibration and thus eliminates unwanted deflection of electron beam.

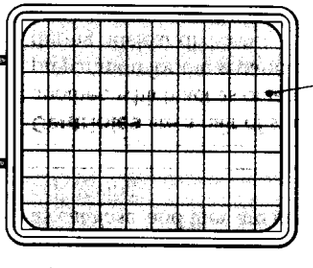


SCANNING COIL: Deflects the electron beam so that it moves over the surface of the specimen.

SPECIMEN

ELECTRON DETECTOR

Amplifier: Boosts signal from electron detector.



Cathode Ray Tube: Presents visual image of scanned surface of specimen by combining input from scanning coil and electron detector.

Sample is Fixed:

↓

Dehydrated:

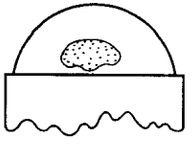
↓

Cleared:

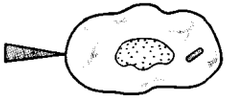
↓

Embedded:

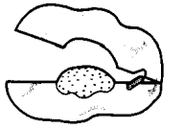
These techniques are potentially damaging to the specimen and may cause the formation of *artefacts* (misleading products of preparation). Thus a specimen for *scanning electron microscopy* is usually prepared by *freeze fracture* which exposes surfaces on or within the specimen.



Specimen frozen in ice



Blade used to fracture frozen specimen

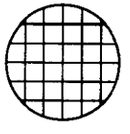


Fracture surface is exposed

Staining:

Biological structures are transparent, or nearly so, to electrons. To increase electron beam deflection (i.e. contrast between different structures) the surface is shadowed with a spray of a metal (commonly gold). This improves the three-dimensional resolution of the surface.

Mounting:



The electron beam does not have to penetrate the specimen, but nonetheless the specimen is commonly mounted on a plastic coated grid so that the non-reflected electrons do not interfere with the electron detector.

Animal cell ultrastructure

Lysosomes are sacs that contain high concentrations of hydrolytic (digestive) enzymes. These enzymes are kept apart from the cell contents which they would otherwise destroy, and they are kept inactive by an alkaline environment within the lysosome. They are especially abundant in cells with a high phagocytic activity, such as some *neutrophils*.

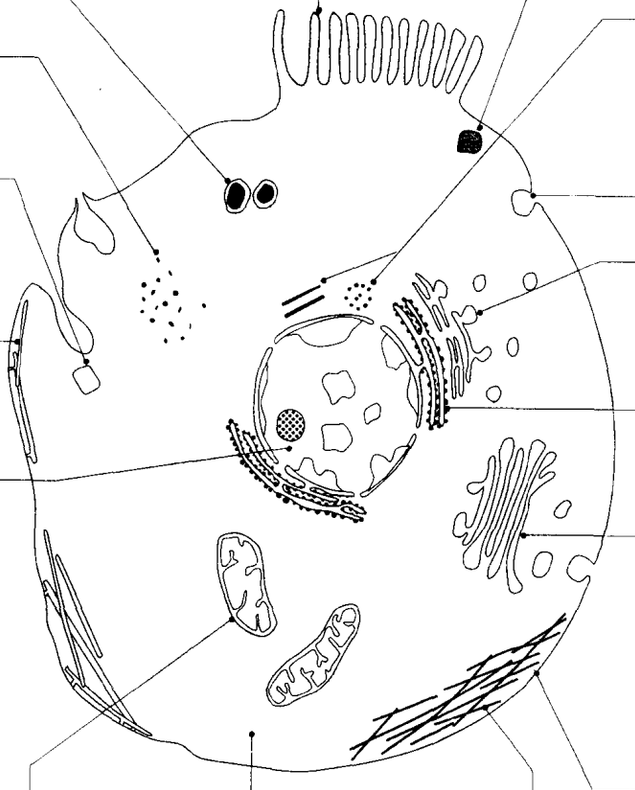
Free ribosomes are the sites of protein synthesis, principally for proteins destined for intracellular use. There may be 50 000 or more in a typical eukaryote cell.

Endocytic vesicle may contain molecules or structures too large to cross the membrane by active transport or diffusion.

Microtubules are hollow tubes of the protein *tubulin*, about 25 nm in diameter. They are involved in intracellular transport (e.g. the movement of mitochondria), have a structural role as part of the cytoskeleton and are components of other specialized structures such as the centrioles and the basal bodies of cilia and flagella.

Nucleus is the centre of the regulation of cell activities since it contains the hereditary material, DNA, carrying the information for protein synthesis. The DNA is bound up with histone protein to form chromatin. The nucleus contains one or more nucleoli in which ribosome subunits, ribosomal RNA, and transfer RNA are manufactured. The nucleus is surrounded by a double nuclear membrane, crossed by a number of nuclear pores. The nucleus is continuous with the endoplasmic reticulum. There is usually only one nucleus per cell, although there may be many in very large cells such as those of striated (skeletal) muscle. Such multinucleate cells are called coenocytes.

Microvilli are extensions of the plasmamembrane which increase the cell surface area. They are commonly abundant in cells with a high absorptive capacity, such as *hepatocytes* or cells of the *first coiled tubule of the nephron*. Collectively the microvilli represent a *brush border* to the cell.



Peroxisome is one of the group of vesicles known as *microbodies*. Each of them contains oxidative enzymes such as *catalase*, and they are particularly important in delaying cell ageing.

Centrioles are a pair of structures, held at right angles to one another, which act as organizers of the nuclear spindle in preparation for the separation of chromosomes or chromatids during nuclear division.

Secretory vesicle undergoing exocytosis. May be carrying a synthetic product of the cell (such as a protein packaged at the Golgi body) or the products of degradation by lysosomes. Secretory vesicles are abundant in cells with a high synthetic activity, such as the cells of the *Islets of Langerhans*.

Smooth endoplasmic reticulum is a series of flattened sacs and sheets that are the sites of synthesis of steroids and lipids.

Rough endoplasmic reticulum is so-called because of the many ribosomes attached to its surface. This intracellular membrane system aids cell compartmentalization and transports proteins synthesized at the ribosomes towards the Golgi bodies for secretory packaging.

Golgi apparatus consists of a stack of sacs called *cisternae*. It modifies a number of cell products delivered to it, often enclosing them in vesicles to be secreted. Such products include trypsinogen (from *pancreatic acinar cells*), insulin (from *beta-cells of the Islets of Langerhans*) and mucin (from *goblet cells in the trachea*). The Golgi is also involved in lipid modification in cells of the ileum, and plays a part in the formation of lysosomes.

Mitochondrion (pl. *mitochondria*) is the site of aerobic respiration. Mitochondria have a highly folded inner membrane which supports the proteins of the electron transport chain responsible for the synthesis of ATP by oxidative phosphorylation. The mitochondrial matrix contains the enzymes of the TCA cycle, an important metabolic 'hub'. These organelles are abundant in cells which are physically *(skeletal muscle)* and metabolically *(hepatocytes)* active.

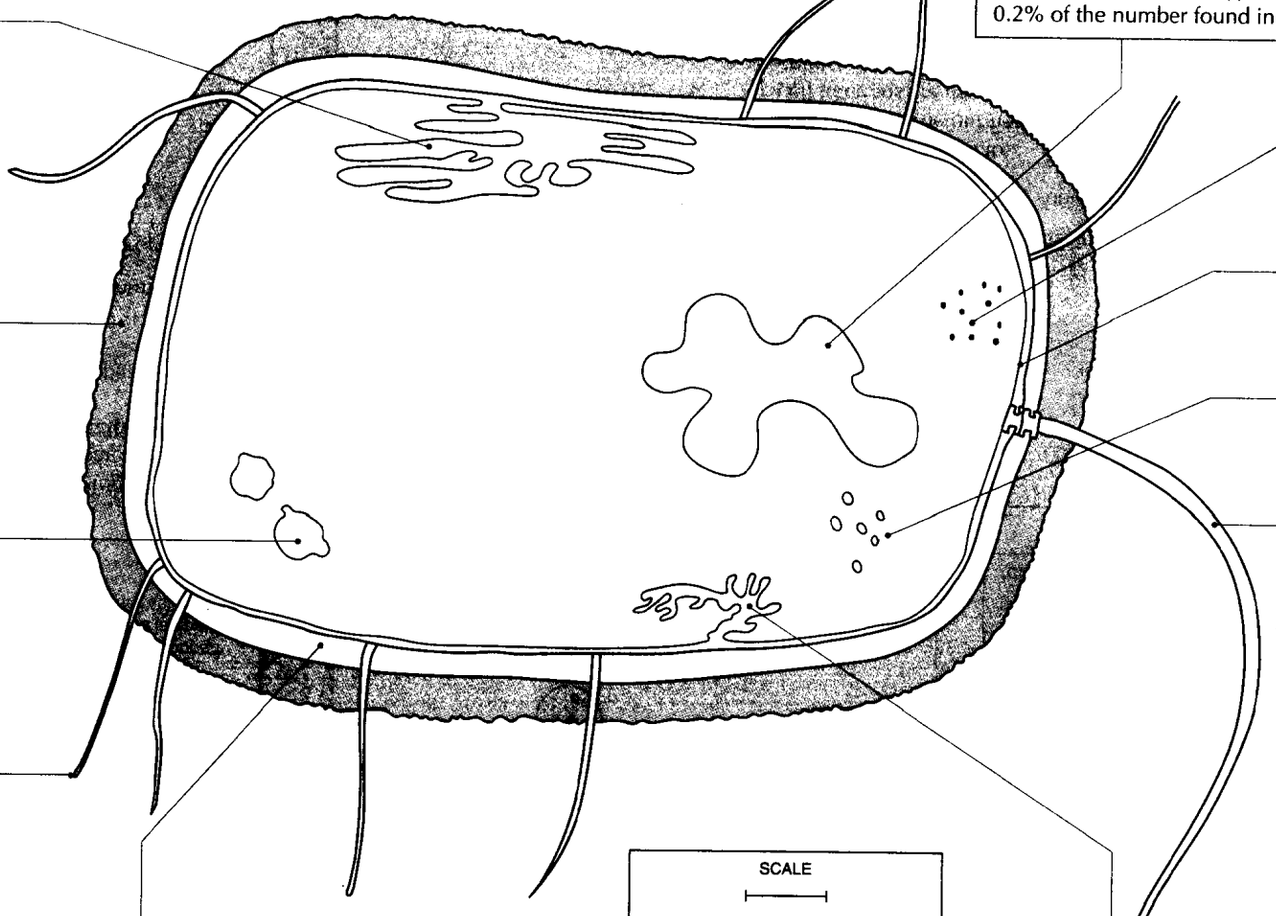
Cytoplasm is principally water, with many solutes including glucose, proteins and ions. It is permeated by the *cytoskeleton*, which is the main architectural support of the cell.

Microfilaments are threads of the protein *actin*. They are usually situated in bundles just beneath the cell surface and play a role in endo- and exocytosis, and possibly in cell motility.

Plasmalemma (plasmamembrane) is the surface of the cell and represents its contact with its environment. It is differentially permeable and regulates the movement of solutes between the cell and its environment. There are many specializations of the membrane, often concerning its protein content.

A prokaryotic cell (e.g. a bacterium) has no true organelles.

* Important comparisons with eukaryotic cells.



Photosynthetic membranes are surfaces for light-absorbing pigments, principally ***bacteriochlorophyll***, but there are no chloroplasts.* N.B. Bacterial photosynthesis does not evolve oxygen.

Capsule is a gummy layer of mucilage which may unite bacteria into colonies (e.g. *Bacillus anthracis*) or confer protection (e.g. rough strain of *D. pneumoniae*).

Plasmids are short pieces of circular DNA which replicate independently of the cell genome. They have been widely used in recombinant DNA technology, but are not present in eukaryotes.*

Pili (or fimbriae) are protein rods concerned with cell-cell attachment. The ***sex pilus*** is involved in DNA transfer during sexual reproduction.

Genetic material is composed of a circle of double-stranded DNA ***which is not enclosed within a nuclear membrane.*** There are typically about 2000 genes, about 0.2% of the number found in a eukaryotic cell.

Ribosomes smaller than those in eukaryotes.* They are scattered throughout the cytoplasm, not supported on an endoplasmic reticulum.

Plasmamembrane is a typical phospholipid bilayer.

Food stores are typically lipid globules or glycogen granules.

Flagellum is responsible for motility of many bacteria. It is much simpler than the flagellum of a eukaryotic cell, being composed of a single cylinder of protein subunits (flagellin). The flagella on eukaryotic cells have a 9+2 arrangement of subunits.* The flagellum does not 'beat' but instead rotates about a 'bearing' anchored in the cell wall to produce a corkscrew motion which drives the cell along.*

SCALE
0.1μm

Cell wall has a rigid framework of ***murein***, a polysaccharide cross-linked by peptide chains. In ***gram-positive*** bacteria the wall is thickened with further polysaccharide and protein deposits, whilst in ***gram-negative*** bacteria the wall is thinner but coated with a lipid layer which provides protection against ***lysozyme*** and ***penicillin.*** This cell wall does not contain cellulose.*
The rigidity of the cell wall prevents osmotic damage (penicillin interferes with this in susceptible gram-positive bacteria) and confers shape on the cell. The three most common shapes are:

COCCUS (SPHERICAL) BACILLUS (ROD) SPIRILLUM (HELICAL)

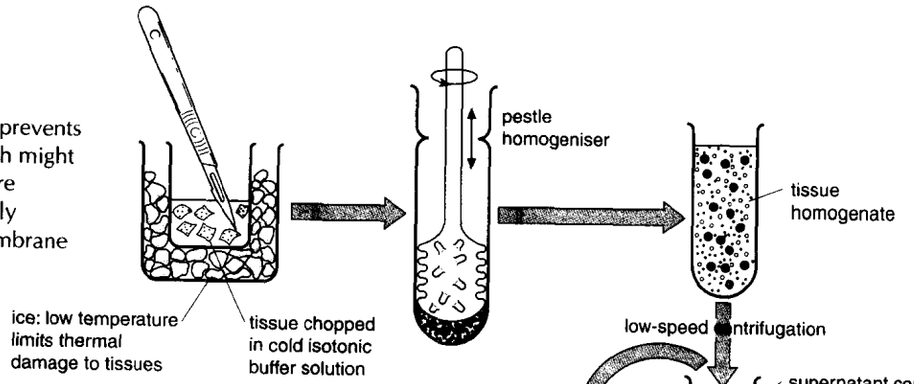
Mesosomes are infoldings of the plasma membrane on which the enzymes associated with respiration are located. There are no mitochondria.*

Differential centrifugation may be used to isolate cell components.

Isotonic Solution prevents osmotic damage to cells and organelles

Motor-driven Homogeniser forces cells between wall of tube and rotating pestle. Shearing forces developed are just sufficient to rupture the cells but not damage the organelles

Buffer Solution prevents pH changes which might otherwise denature proteins, especially enzymes and membrane proteins.

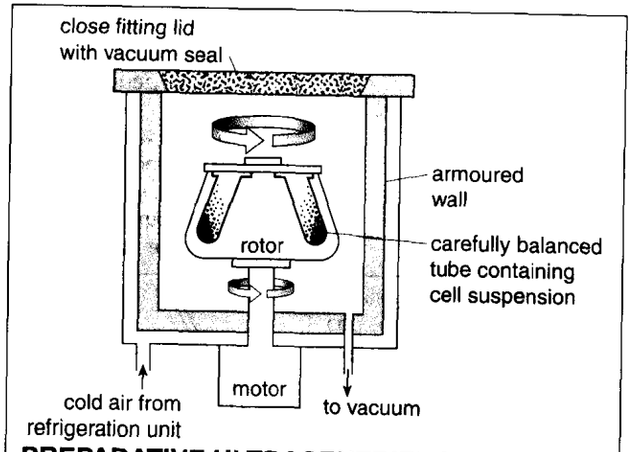


Cell extracts (tissue homogenate) are centrifuged at progressively greater speeds in order to separate (fractionate) their components. The main factors governing sedimentation are:

1 Magnitude of centrifugal force, which depends on the speed of rotation
2 Size of suspended organelles
3 Density of organelles relative to suspension medium

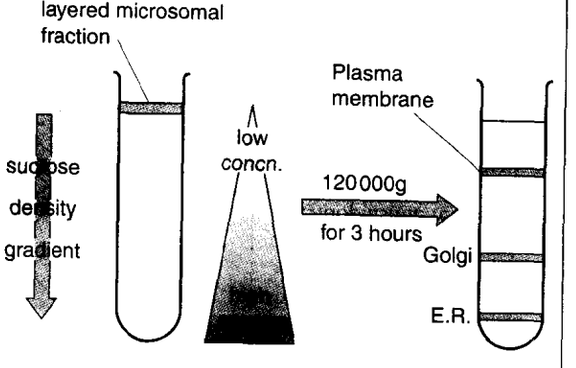
Exact times and speeds of centrifugation vary from one tissue to another, and are determined by trial and error. Typical values:

Low Speed – 1000g for 10 minutes
Medium Speed – 20 000g for 20 minutes
High Speed – 80 000g for 60 minutes



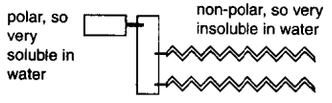
PREPARATIVE ULTRACENTRIFUGE: the cell homogenate is contained in balanced tubes that are inserted into metal rotor. The rapid rotation of the rotor generates enormous centrifugal forces that cause particles in the homogenate to sediment. The vacuum reduces friction: it thus prevents heating of the rotor and allows the refrigeration system to keep the sample at 4°C.

The microsomal suspension can be further purified by **equilibrium density centrifugation** which involves layering the suspension on top of a **sucrose density gradient**. When the gradient is centrifuged organelles and membranes migrate and form bands in the region of the gradient equal to their density. The purified cell fractions are then collected by puncturing the tube bottom and collecting samples of the solution.

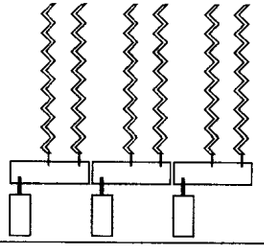


Structural components of membranes permit fluidity, selective transport and recognition, integrity and compartmentalization.

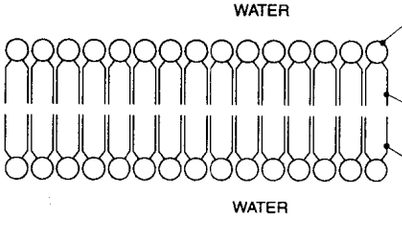
Because of the different solubility properties of the two ends of phospholipid molecules ...



... such molecules form a layer at a water surface



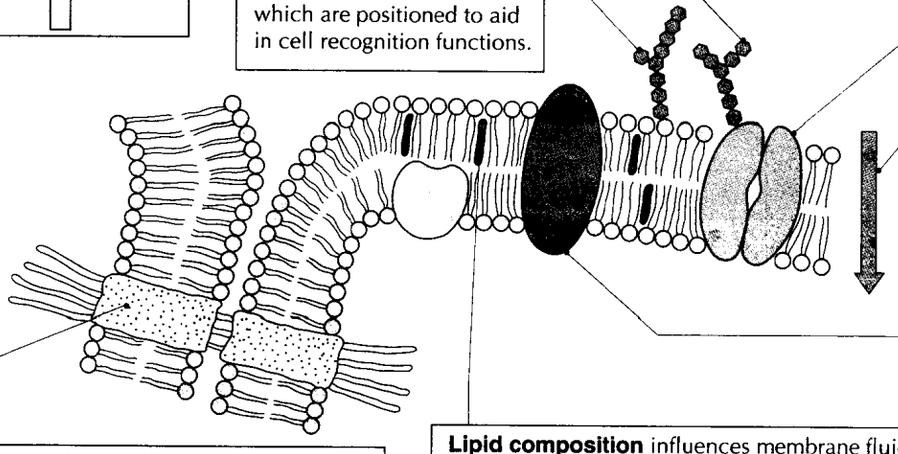
and a ***phospholipid bilayer*** can act as a barrier between two aqueous environments.



Hydrophilic heads point outwards: form hydrogen bonds with water

Hydrophobic tails point towards one another: this maximizes hydrophobic attractions and excludes water

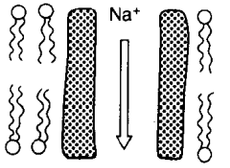
Surface carbohydrates (collectively the ***glycocalyx)*** are usually oligosaccharides which are positioned to aid in cell recognition functions.



Cell adhesion proteins firmly attach adjacent cells to one another, this is particularly important in epithelia. These proteins also serve as internal anchorage points for protein tubules of the cytoskeleton.

Lipid composition influences membrane fluidity: unsaturated fatty acid tails are 'kinked', limit close packing of the hydrophobic tails and so ***increase*** fluidity, but cholesterol may interfere with lateral movement of hydrophobic tails and thus ***reduce*** membrane fluidity.

Diffusion through aqueous channels in pore proteins: transmembrane proteins may have aqueous channels through which charged molecules may pass and thus avoid the hydrophobic tails of the phospholipid molecules.



Some channels are open all of the time, but others are ***gated*** (they open and close only in response to a stimulus, such as a change in the membrane's electrical potential). Such ***gated channels*** are vital to the operation of nerve and muscle, where movements of Na^+, K^+ and Ca^{2+} initiate information transfer.

Diffusion across the lipid bilayer is responsible for the movement of ***small, uncharged molecules.***

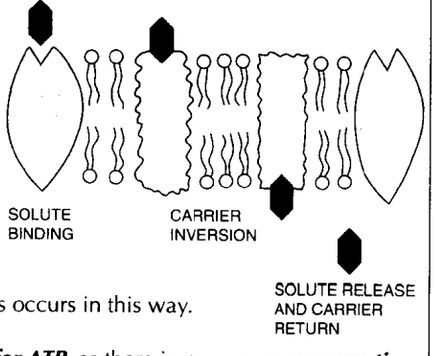
Thus O_2, H_2O, CO_2, urea and ethanol cross rapidly (they 'squeeze between') the polar phospholipid heads then dissolve in the lipid on one side of the membrane and emerge on the other.

Large or ***charged molecules*** cannot cross the lipid bilayer.

Thus Na^+, K^+, Cl^-, HCO_3^- and glucose do not cross in this way.

Active transport uses a ***carrier protein*** to transport a solute across a membrane but ***energy is required*** since transport may be ***against a concentration gradient.*** Typically ATP is hydrolysed and the binding of the phosphate group to the carrier changes the protein's conformation in such a way that the solute molecule is moved across the membrane.

Facilitated diffusion uses a ***carrier protein*** to transfer a molecule across a membrane ***along*** its electrochemical gradient. The binding of the solute alters the conformation of the carrier so that its position in the membrane changes and the solute molecule is discharged on the other side of the membrane. Glucose uptake by erythrocytes occurs in this way.



N.B. There is ***no requirement for ATP***, as there is ***no energy consumption.***

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