Uptake of nutrients by the cell

The first step in nutrient use is uptake of the required nutrients by the microbial cell,uptake mechanism must be specific-that is the necessary substances,and not others,must be acquired.Nutrients must pass through a selectively permeable plasma membrane that will not permit the free passage of most substances.

The most important transport mechanisms are :

1-Passive diffusion : the process in which molecules move from a region of higher concentration to one of lower concentration because of random thermal agitation.The rate of passive diffusion is dependent on the size of the concentration gradient between a cell's exterior and it's interior,very small molecules (H_2O,O_2 & CO_2) often move across membranes by passive diffusion. 2-Facilitated diffusion : the rate of diffusion across selectively permeable membranes is greatly increased by using carrier proteins, called permeases, which are embedded in the plasma membrane. Because carrier aids the diffusion process,it is called facilitated diffusion .The rate of transport increases with the concentration gradient much more rapidly and at lower concentrations of the diffusing molecule than that of passive diffusion.The curve below resembles an enzyme – substrate and is different from the linear response seen with passive diffusion .Carrier proteins also resemble enzymes in their specificity for the substance to be transported ;each carrier is selective and will transport only closely related solutes.

3 -Active transport : M.O often live in habitats with very dilute nutrient sources,must be able to transport and concentrate these nutrients, thus facilitated diffusion mechanisms are not always adequate ,and other approaches must be used ,the two most important transport mechanisms in such situations are ; active transport & group translocation , both energy –dependent processes .

Active transport; is the transport of solute molecules to higher concentrations,or against concentration gradient,with the use of metabolic energy.The carrier proteins or permeases bind particular solutes with great specificity,it is also characterized by the carrier saturation effect at high solute concentration.

4- Group translocation ; Many bacteria take up molecules by group translocation,a process in which a molecule is transported into the cell while being chemically altered. It is energy –dependent transport because metabolic energy is used. In the 1,2,3 types the solute molecules move across a membrane without modification.

The best –known group translocation system is the phosphoenolpyruvate;

Sugar phosphotransferase system (PTS).It is transports a variety of sugars into cells while phosphorylating them using phosphoenolpyruvate (PEP) as the phosphate donor.

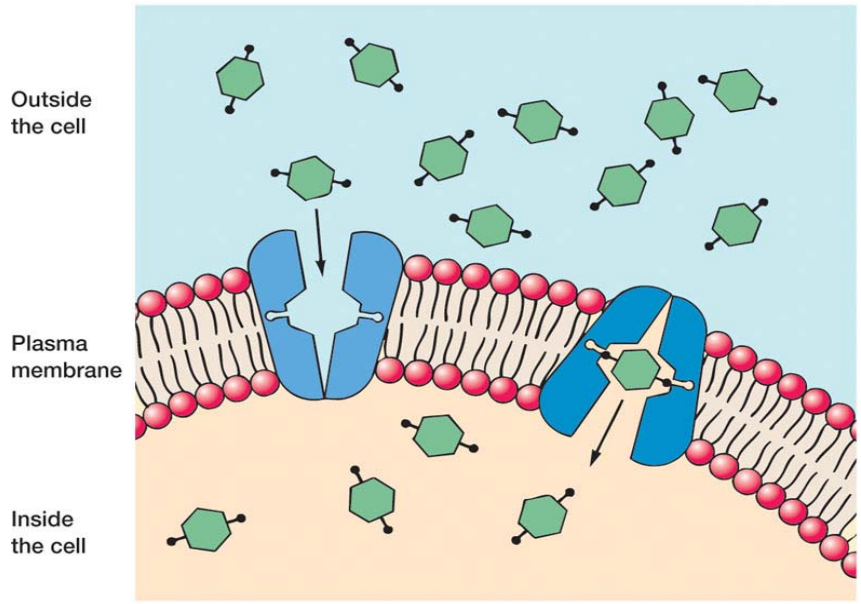

Figure -1 A model of facilitated diffusion the membrane can carrier change conformation after binding an external molecule and subsequently release

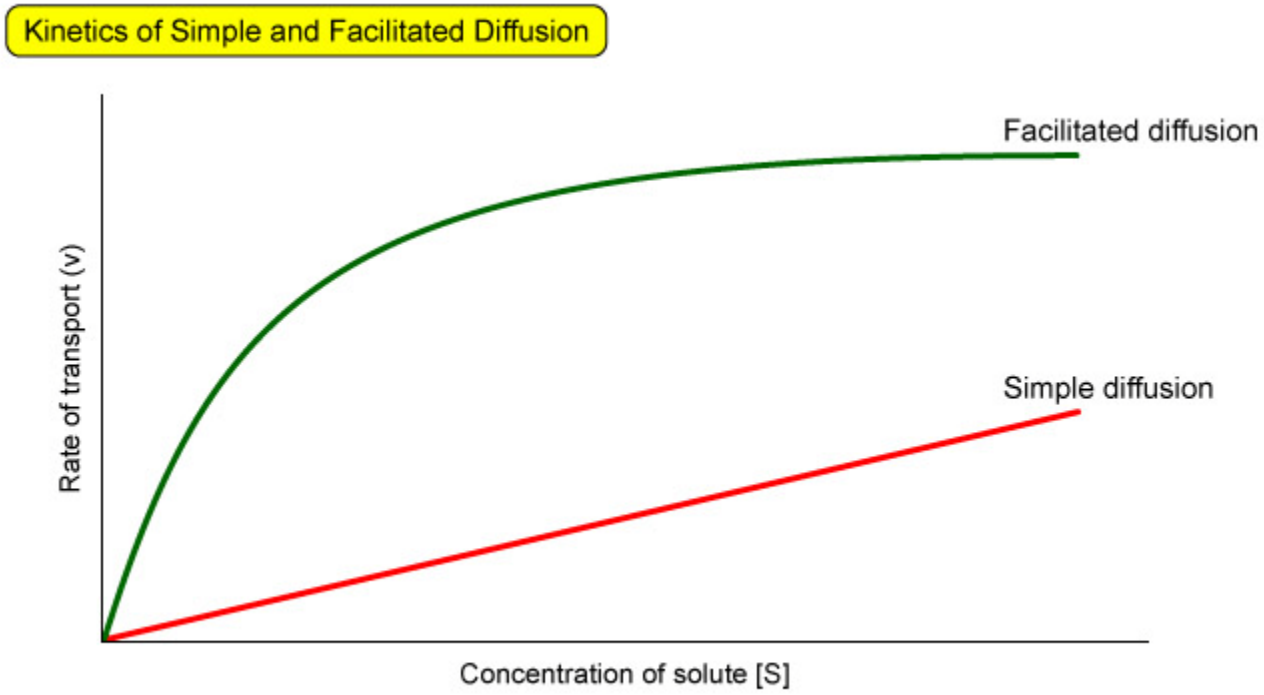

Figure -2 The kinetics of simple diffusion and facilitated diffusion. The rate of transport (v) is plotted against the concentration of solute ([S]) for simple diffusion of a solute (shown in red) and facilitated diffusion of a solute by a carrier protein (shown in green). Transport by a carrier protein is much more rapid than transport by simple diffusion. Facilitated diffusion becomes saturated at high solute concentrations, and higher solute concentrations do not significantly increase the rate of transport.

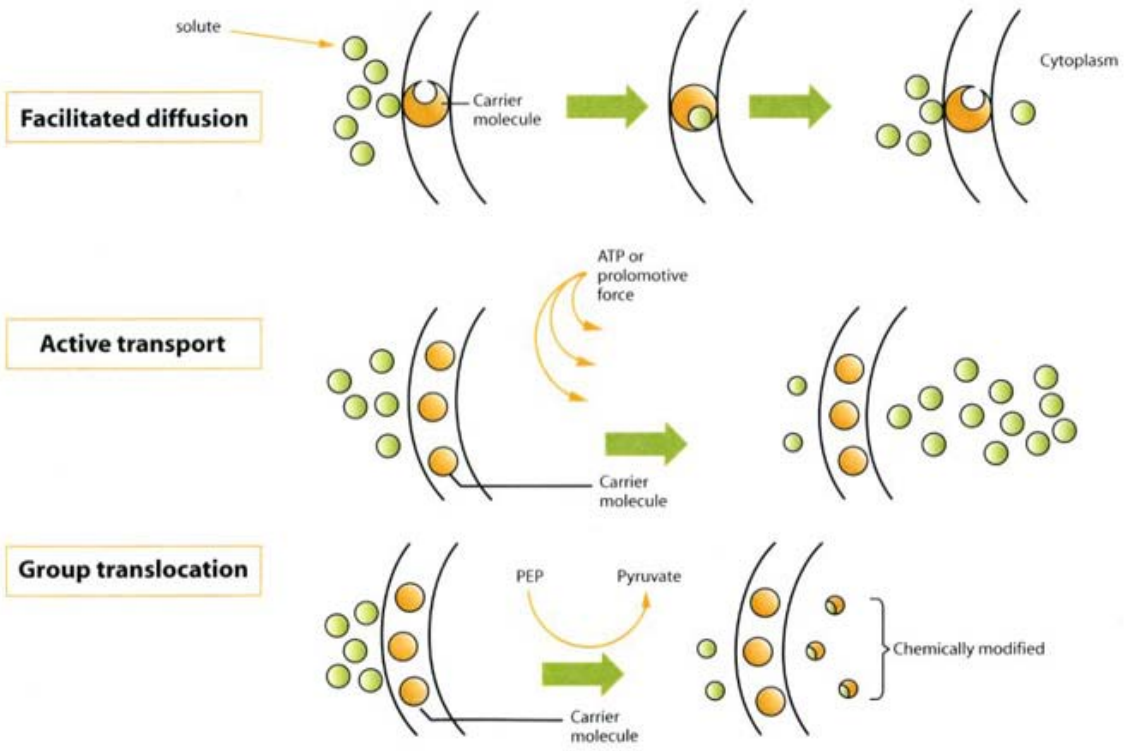

Figure -3 Operation of bacterial transport systems. Bacterial transport systems are operated by transport proteins (sometimes called carriers, porters or permeases) in the plasma membrane. Facilitated diffusion is a carrier-mediated system that does not require energy and does not concentrate solutes against a gradient. Active transport systems such as Ion-driven transport and Binding protein-dependent transport, use energy and concentrate molecules against a concentration gradient. Group translocation systems, such as the phosphotransferase (pts) system in *Escherichcoli*,use energy during transport and modify the solute during its passage across the membrane.

Protein secretion. Proteins destined for the inner membrane or the periplasmic region are secreted by signal secretion dependent (sec-dependent) secretion machinery. Proteins destined for the outer membrane (gram negatives) or the external environment use specialized protein export systems.

Toxins are secreted into the extracellular mileu and target host cells by receptor-mediated membrane damage or endocytic uptake.

The type III and type IV systems require host cell contact and directly inject proteins into the host cell. The folding state of secretion substrates may dictate the mode of tranport. In some cases, the first step, transport across the IM, uses the sec-dependent secretion system. This includes type II and type IV secretion, and may allow for folding, processing, oridation, and assembly into quarternary structure. This may be particularly important for toxins.

Type I and type III secretion are sec-independent. Proteins exported by the type III and type IV secretion may be secreted in unfolded states (though we really don't know).

These specialized protein secretion systems are important in pathogenesis and their substrates are often virulence factors that target host cell proteins. Recognition of secretion substrates in the bacterial cytoplasm involves diverse signals that are different depending upon the secretion mechanisms. Proteins dependent upon the Sec system have N-terminal greasy signals, while type I secreted proteins have a Cterminal signal sequence. The recognition signal for type III secreted proteins is complex and controversial.

Related substrates can be transported by diverse pathways. Many AB% toxins are substrates for type II pathways, whereas *Bordetella pertussis* toxin uses a modified routing via a type IV secretion apparatus. Some proteinases that are secreted via a type I pathway by one organism are transported by the type II machinery in other organisms.