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On the Biological Applications of Liquid Membranes: A Short Review

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ABSTRACT

Studies on permeation through membranes have attracted attention during the last few decades because of the various applications of membranes in our day today life. Studies on Bulk liquid membranes (BLM). Emulsion liquid membranes (ELM) Supported liquid membranes (SLM) all have led to wonderful applications in technology and biology. An attempt is being made to throw light on the applications these liquid membranes in various biological fields viz facilitated transfer controlled release of drugs and all pharmaceutical applications.

Introduction

To define a Membrane in a precise and complete manner is a difficult task because the definition should comprise all the facts of membrane behavior which in itself is very complex in nature and alters with surrounding environment.

Lakshminarayanaiah[1] described the membrane as a phase usually heterogeneous, acting as a barrier to the flow of molecular or ionic species present in the bulk phase in contact with two surfaces.

According to Lorimer[2] a membrane is a phase which separates two other phases, prevent bulk mixing of these two phases but allows pathway of energy and of matter between the phases.

Another definition as given by Bean[3] is a membrane is a phase which act as a barrier to the flow of matter or heat and in most cases with exceptions of pure liquids and soilids.

Lonsdale[4] has recognized the membrane as a thin, usually polymeric film with permselectivity, permselectivity is a property of membrane.

Taking different kinds of definition of membranes into consideration, we can say that a membrane is a barrier between two phases. This barrier is semipermeable. If an immiscible liquid serves as a membrane between two liquid or gas phases, then it is considered to be a liquid membrane.

Transport phenomena occurring across membranes are of considerable interest in chemistry, chemical engineering and biology[5-17].

Liquid Membranes in Biological Applications

A recent study with biotechnology application relates to amino acid extraction. Schugerl and Coworkers[18] used a quarternary ammonium carrier in an emulsion liquid membrane system for enzyme catalyzed preparation of L – aminoacids. Frankenfield et al. discussed wide variety of biomedical ELM application includings enzyme encapsulation blood oxygenation and treatment of chronic uremia.

Phenols and mercaptans are thought to be the most crucial toxins in coma hepaticum[19]. In case of liver failure, their concentrations in blood increase sharply, concentrations of phenols in blood as high as 1-5Nm have been measured[20]. Together with increased fatty acid[21] the toxins not only harm the brain but

also the regenerating liver in a synergestic effect. Aremoval of these toxins during coma hepaticum opens a chance to support the livers self regeneration[22]. The extraction of phenols from blood and plasma is accomplished by liquid surfactant membrane technique[23]. Liquid membrane have been widely used in biotechnological application[24-30]. Biological implications of liquid membrane hypothesis have also been investigated recently[31-32].

1. Liquid Membranes in Facilitated Transport

For immobilized liquid membranes, reactive membranes can be fabricated by dissolving carrier species into an appropriate solvent and then introducing the solution into porous membrane support Way et al. have discussed the criteria which influence selection of immobilized liquid membranes containing carrier facilitated systems. D. T. Friesen et al. recovered citric acid using SLM through facilitated transport.

Facilitated transport (FT) through liquid membranes is a phenomenon that allow the flux of a particular molecule in the gas phase (permeate) through the membrane to be enhanced. This enhanced flux is due to a reversible reaction between the permeate and a chemical carrier, which has been incorporated in the membrane, to form a carrier permeate complex (Fig 1.)

The complexation chemistry itself can be applied to analytical techniques such as liquid-liquid extraction and chromatography or to industrial separations such as extractive and azeotropic distillation and stipping processes. Transport studies utilizing synthetic membranes are important for understanding biological membrane process. FT through liquid membrane is particularly attractive for industrial separations because the energy requirements are low yet it is possible to achieve high fluxes and selectivity. FT membrane systems have already been used in the treatment of heavy metals, such as chromium in hydrometallurgical ore processing and rare earth elementsin the extraction of oxygen from air.

Facilitated transport of gases has been the subject of numerous investigations which are summarized in recent articles. Due to great biological importance, oxygen transport via a haemoglobin carrier was one of the first facilitated transport systems studied. Facilitated transport is concerned with the reversible reaction between the solute and carrier and is not coupled to other components. This reaction normally can take place throughout the liquid membrane phase. (Fig. 2)

2. Liquid Membranes in Controlled Release Technology

Broadly defined, controlled release refers to the regulated delivery of an active agent from source to target. Different methods exist for achieving a given delivery rate over a given duration. Here we consider only the functional classes that involve the use of membranes.

The safe, efficient use of many substances in medicine, agriculture, pest control and consumer products depends on precisely regulating the rate and quantity of their delivery. In human and animal health care, for example the administration of drugs has to be maintained above specific levels of obtain the desired efficacy, but below the level where toxic side effects occur.

One type of controlled release device involves a reservoir containing an active agent at its solubility limit, and with excess agent present, is surrounded by a membrane. The solubility and diffusivity of the agent in the membrane determine its release rate. Devices of this type already on the market include those used for administering steroids for fertility control or hormone therapy, and intraocular dispensing of pilocarpine for glaucoma control. In matrix devices, solute particles are suspended in a polymeric

matrix which also regulates release at a rate that declines as the inverse square root of time according to the classic Higuchi model. The temporal pattern of release from simple matrix devices can be advantageously moderated by encasing with a rate limiting membrane.

An exciting new development in the controlled release technology integrates biosensing and control functions in a single membrane device. The response mechanism is shown in Fig 3. The implication of this development go beyond the obvious application to the treatment of diabetes, the same principles and being applied to the engineering of membrane devices with other biochemical and chemical response functions.

3. Liquid Membranes in Pharmaceutical Applications

Liquid membrane configurations such as supported liquid membranes (SLM) and emulsion liquid membranes (ELM) can be applied to a variety of fields of biomedicines. These involve. Drug over doses chronic uremia, cholesterol removal and toxin removal. Liquid membranes have been successfully used for processing whey protein in the dairy industry, haemodialysis treatments and biomedical research.

In the pharmaceutical field the use of a carboxylic cation exchange resin for a recovery and purification of the antibiotic streptomycin has been quite spectacular. This application is of extreme intrest because of the high capacity and selectivity of the resin for streptomycin, the purity of streptomycin eluted from the resin and the fact that the resin has been used in many istallations for more than 1000 cycles without any apparent loss in activity.

More conventional membrane systems, such as hollow fibre devices, are being considered as housing units for genetically programmed microbes. Water based liquid membranes utilizing alpha, beta, and gamma cyclodextrin carriers are able to selectively transport certain isomers. Enantiomeric enrichments were demonstrated from six racemic mixtures, two of which were drugs. Several new synthetic agents show high affinity sor binding adenine derivatives. The structures feature complementary hydrogen bonds that cause the molecular chelation of the purine molecules. The high lipophilicity of the agents permits the transport of adenosine and deoxyadenosine across organic liquid membranes. The use of synthetic receptors for small biological targets may have application in drug delivery.

Excitation of membranes is generally observed in biological systems for recognition of hormones, drugs, taste and odor on or within a cell membrane. A chemical compound may act on a biomembrane thus inducing electric impulses. Chemical compound recognition and identification are based on particular impulses as a result of the interaction of a membrane with a chemical compound. It thus follows that such excitation is importantly involved in a biomimetic chemical sensing.

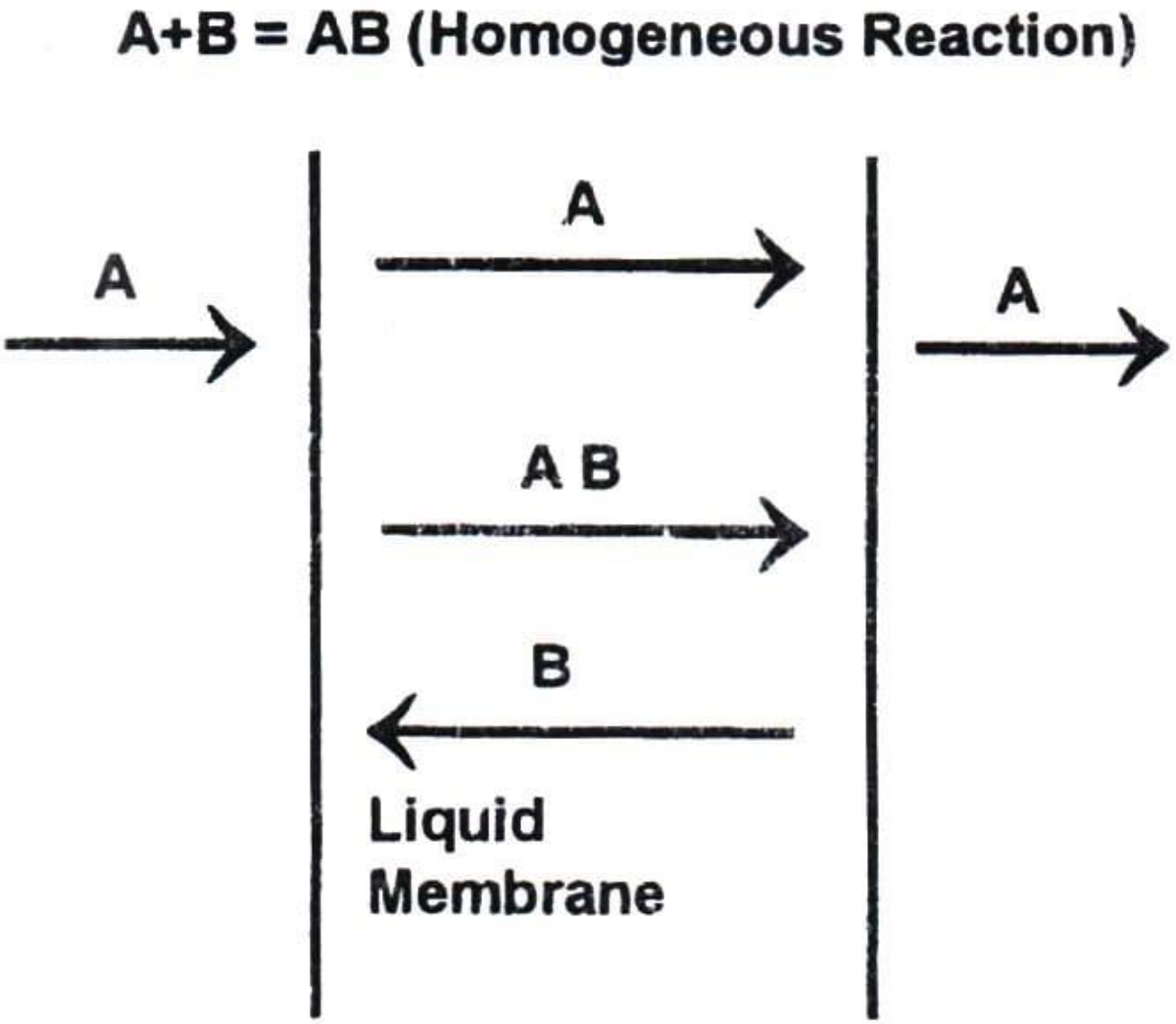

Fig. 1 : A Facilitated Transport

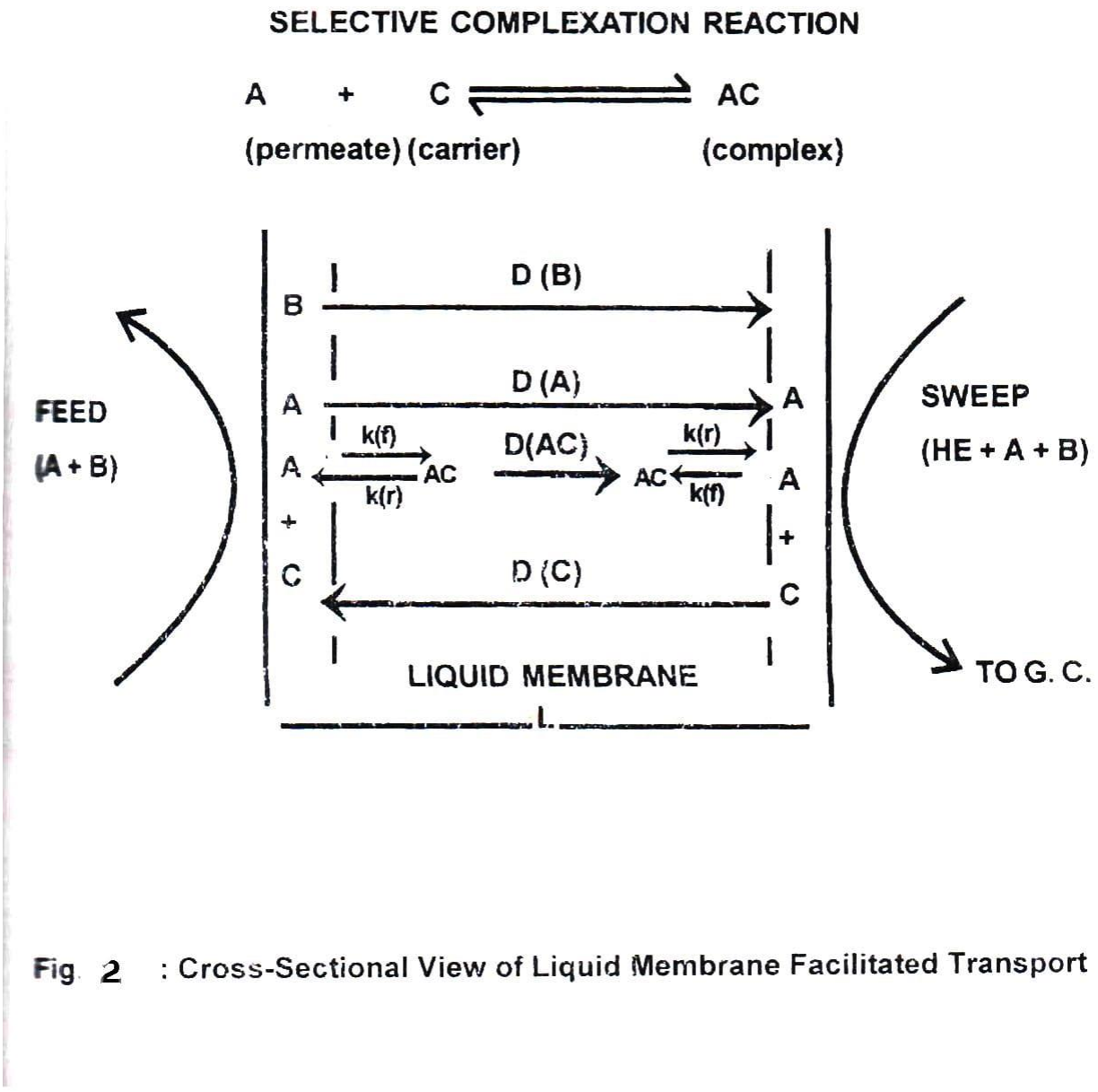

Fig. 2 : Cross-Sectional View of Liquid Membrane Facilitated Transport

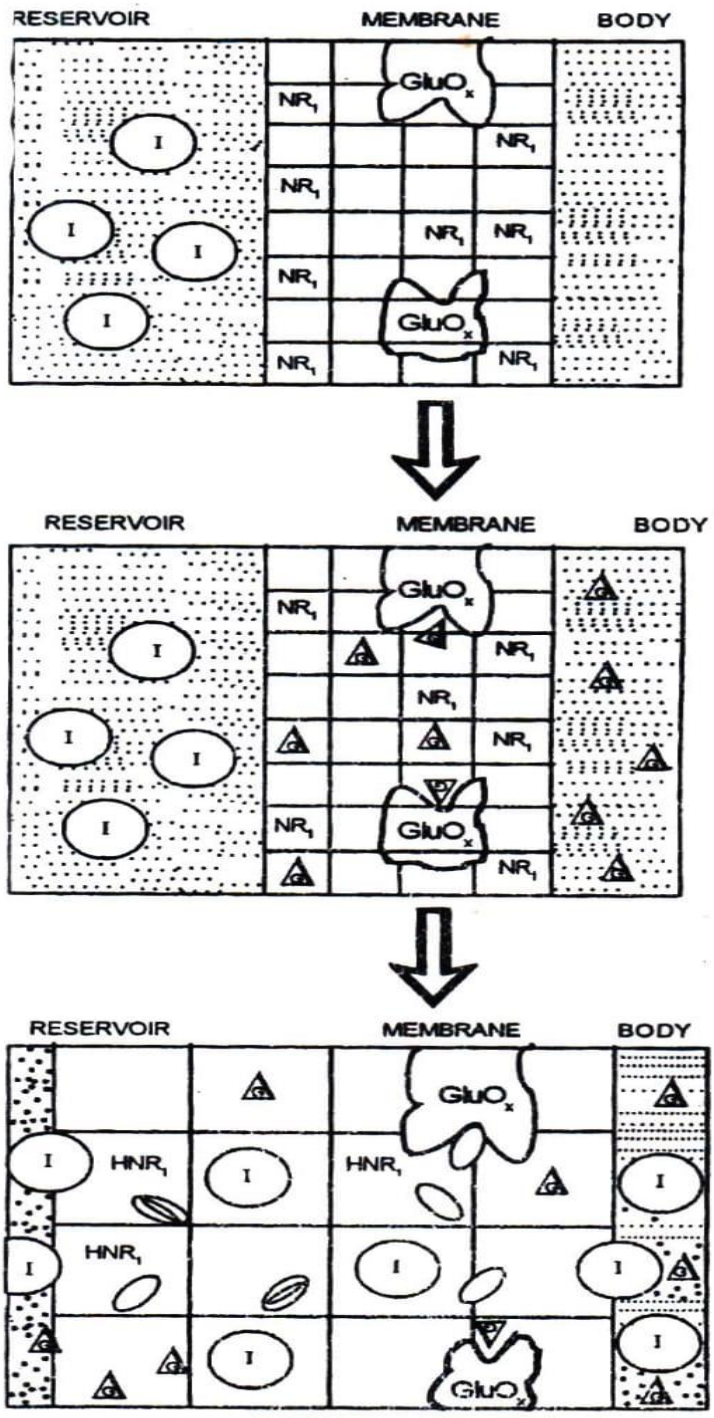

Fig.3 : Controlled Release Process Through Liquid Membran

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