L- 41 Definition of Biotechnology

Introduction

- **Biotechnology is the**
- **industrial use of**
- **micro-organism and**
- **living animal and plant cells**

to produce products.

Biotechnology encompasses the manufacture of ……

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L- 41 Definition of Biotechnology

Introduction

Biotechnology encompasses the manufacture of :

- **Antibiotics,**
- **Vaccines,**
- **Vitamins and**
- **Plastics.**

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L- 41 Definition of Biotechnology

Introduction

- **Pollution control,**
- **toxic waste disposal**
- **using bacteria,**
- **production of new fuels and**

all possible things through "biotechnology".

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L- 41 Definition of Biotechnology

Biotechnology can be defined by number of ways:-

"Biotechnology is the application of

- **biochemistry,**
- **Biology,**
- **microbiology and**
- **chemical engineering to**

industrial process and products and on environment".

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L- 41 Definition of Biotechnology

"Biotechnology is the integrated use of

- **biochemistry,**
- **microbiology and**
- **engineering sciences**
- **in order to achieve**

technological application of the

- **capabilities of micro-organism cultured tissue cells and**
- **parts thereof."**

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L- 41 Definition of Biotechnology

So we can say

“Biotechnology is a multidisciplinary science, which includes

- **microbiology,**
- **chemistry,**
- **biochemistry,**
- **chemical engineering and genetics”.**

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L- 41 Definition of Biotechnology

It has many application and significant contributions in different fields like

- **food,**
- **agriculture,**
- **energy production and**
- **pollution control.**

It has multidisciplinary nature.

Fig. shows its multidisciplinary nature.

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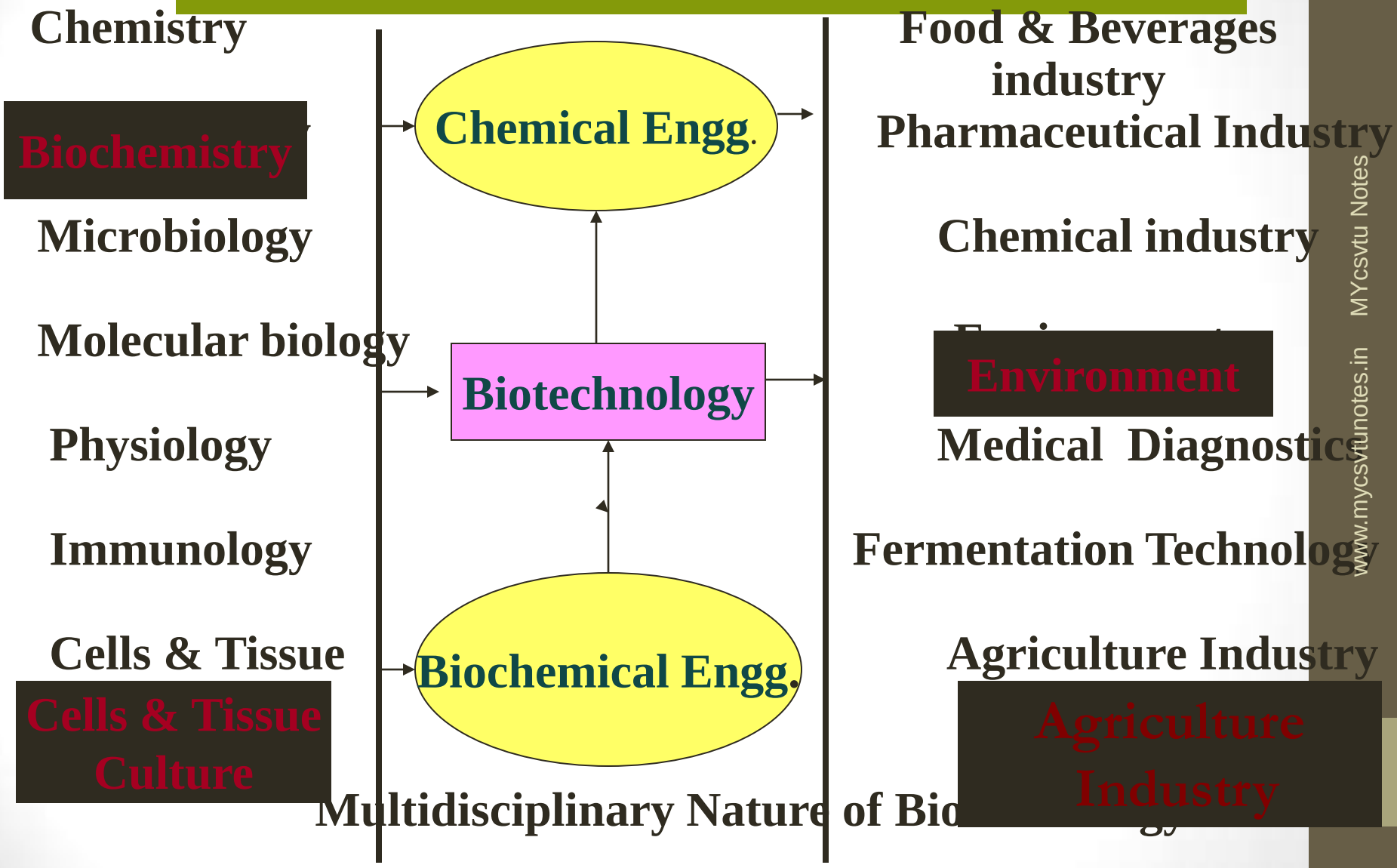
L- 41 Definition of Biotechnology



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L-42 Current Status of Biotechnology in Environmental protection

Biotechnological applications to environment protection of industrial pollution management is very important.

***Biodegradation is the ultimate fate of a material that enters the environment.**

- **The current philosophy on the issue of degradation is that –**

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L-42 Current Status of Biotechnology in Environmental protection

- **It is not an ideal option.**
- **It represents waste of material.**
- **It is valuable only if waste are hazardous and permanent elimination is sought.**
- **Products of degradation should come in use if possible.**

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L-42 Current Status of Biotechnology in Environmental protection

- **Bio-energy (biogas, ethanol, hydrogen gas) generation from treatment of liquid/solid wastes.**

- **Heavy metal recovery from various industrial effluent.**

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L-42 Current Status of Biotechnology in Environmental protection

Effluent treatment for variety of industries.

- **Waste gas treatment and deodorization**
- **removal of phenol,**
- **mercaptans,**
- **hydrocarbons,**
- **hydrogen sulfide.**

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L-42 Current Status of Biotechnology in Environmental protection

- **Biomass/food/mushroom production from wastes using appropriate biological agents.**
- **Modification of process or new processes /products to prevent pollution. (In tanning/paper/plastic industries).**

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L-42 Current Status of Biotechnology in Environmental protection

(In tanning/paper/plastic industries).

- **Added value processes involving the conversion of wastes into useful products**
- **(production of animal feed from waste of food processing plants etc.).**

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L-42 Current Status of Biotechnology in Environmental protection

Role of Biotechnology in Environmental Protection:

Biotechnology can offer

- **cheap, compact and**
- **effective process**
- **instead of bulky,**

expensive and space wasting ones.

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L-42 Current Status of Biotechnology in Environmental protection

Its philosophy is linked with

- **conservation and bye-products recovery,**
- **and it is not stimulated by market pressures.**
- **Its initial cost is high, the treatment may be less costly overall.**

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L-42 Current Status of Biotechnology in Environmental protection

- **Its full potential is not realized and**
- **laboratory and field successes have not translated in to applications.**
- **Important low-value products, if any, are obtained (like ethanol).**

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L-42 Current Status of Biotechnology in Environmental protection

Biotechnology can become effective if

- **technical,**
- **legal, economic,**
- **business and market**

issues are successfully tackled.

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L-42 Current Status of Biotechnology in Environmental protection

Biotechnological Process:

- **A bioprocess is any large scale operation which involves the**
- **transformation of "substrate"**
- **(i.e. biological or non-biological raw material upon which a microorganism acts) into**

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L-42 Current Status of Biotechnology in Environmental protection

Biotechnological Process:

- **some 'products'**

  (i.e. biomass, metabolite or transformation products of a starting material),

- **by means of micro-organism,**
- **animal or plant cell culture or**
- **by material (e.g. enzymes, organelles) derived from them.**

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L-42 Current Status of Biotechnology in Environmental protection

- **Most biotechnological process can be represented as:**

Process

Substrate +Micro –Organism Products.

Engineering

There are three steps **in any biotechnological process:-**

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L-42 Current Status of Biotechnology in Environmental protection

i) Pre treatment

ii) Bio reaction and

iii) Downstream processing

i) The Pre-Treatment Step:

Converts raw material or feed stock or substrate into a form

which is suitable for processing.

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L-42 Current Status of Biotechnology in Environmental protection

In this following steps are added-

- **sorting,**
- **sieving,**
- **hydrolysis,**
- **sterilization etc.**

ii) Bio Reaction Step:

This is done in 'bioreactor', where desired biotransformation take place.

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L-42 Current Status of Biotechnology in Environmental protection

The commonly used operation in bio reaction are :

- **Biomass production,**
- **metabolite biosynthesis,**
- **immobilized enzyme.**

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L-42 Current Status of Biotechnology in Environmental protection

iii) Downstream Processing:

- **The material produced in the bioreactors is further processed in downstream section.**

- **The commonly used operation in downstream processing are –**

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L-42 Current Status of Biotechnology in Environmental protection

(Downstream Processing)

The commonly used operations are –

- **Filtration,**
- **centrifugation,**
- **Sedimentation,**
- **chromatography,**
- **evaporation,**
- **drying and packing.**

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L-42 Current Status of Biotechnology in Environmental protection

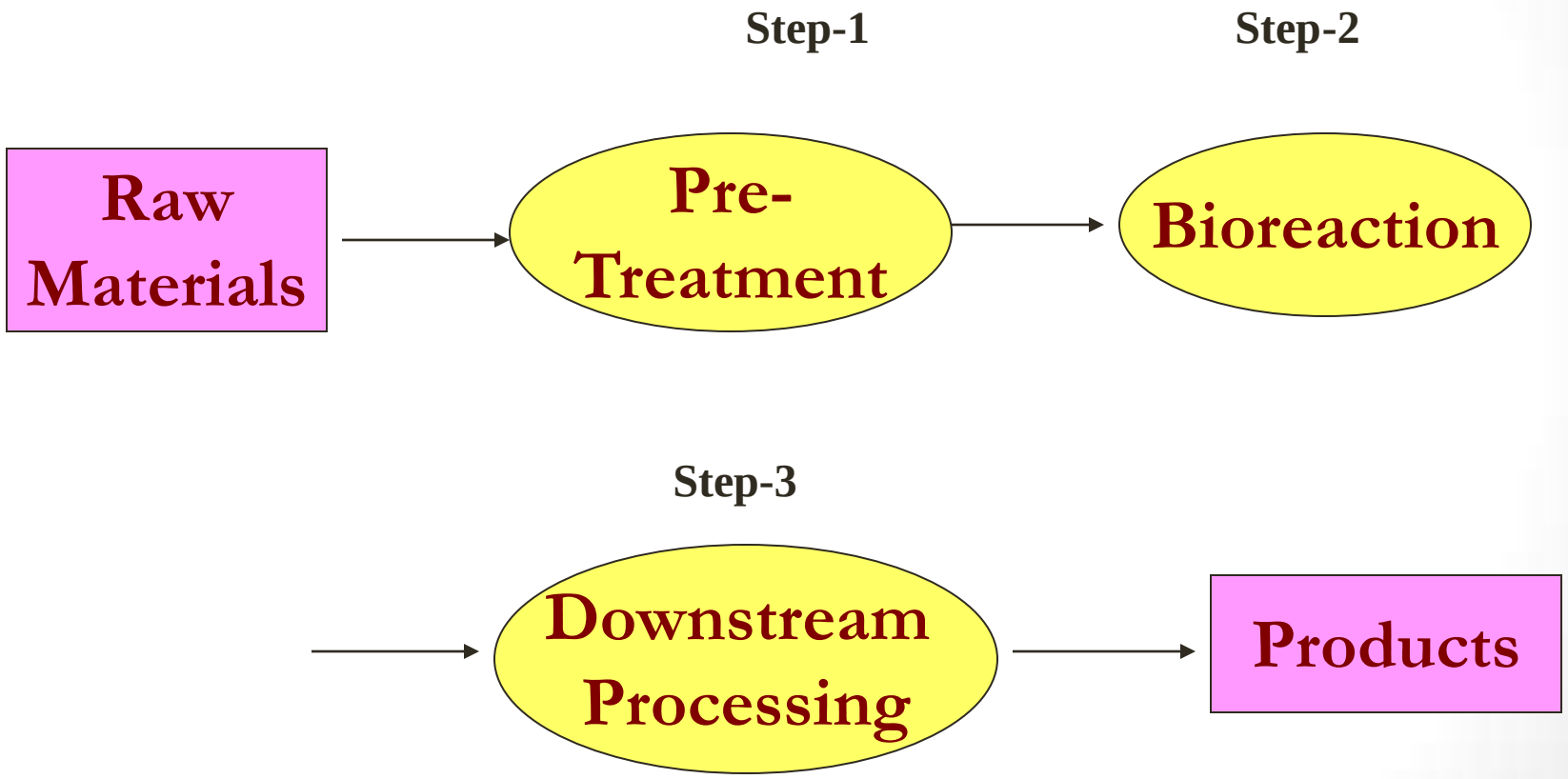

Fig.2 The Bioprocess Stages

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L-43 Biofuels & Biofertilizers

BIO FUELS

- **The bio fuels are biologically produced fuel. Production of biofuels involve**
- **conversion of diffused & inconvenient to use source of energy such as**

- **biomass and sun light into**
- **dense and convenient to use fuels.**

This process constitute the

‘fuel technology’.

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L-43 Biofuels & Biofertilizers

Some characteristics features of bio fuels:

1. **Bio fuels are mostly derived from biomass, which is**

- **renewable,**
- **low cost and**
- **easily available.**
- **2. Compared to fossil fuels, biofuels emit low CO_2 .**

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L-43 Biofuels & Biofertilizers

Some characteristics features of bio fuels:

3. Pollutant gases such as SO_2 are not produced by bio fuels.

4. The environment also gets cleaned up.

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L-43 Biofuels & Biofertilizers

Some Undesirable character of Bio-Fuels:

1. **Very large scale production is required and usually near to the site of use.**
- **2. Very large requirement of substrate, this requires large are of land.**
- **3. Low value of product and**

4. Low profit margin.

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L-43 Biofuels & Biofertilizers

Biomass for Energy Production:

During photosynthesis

- **Solar energy is converted to biomass**
- **which is stored and used as fuel.**

Biomass is nothing but

- **living matters or its residues**
- **which are used as a source of energy.**

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L-43 Biofuels & Biofertilizers

Sources of Biomass for fuel:

Land crops such as

- **eucalyptus, maize, sugarcane and pine tree.**

Aquatic plant such as

- **water weeds and algae.**

Wastes such as

- **domestic sewage, wood and**

crop residues such as

- **straw, husk, bagasse and molasses.**

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L-43 Biofuels & Biofertilizers

The advantages of using bio-masses as a fuel are –

i) Biomass is renewable and it can be stored.

ii) Fuel from biomass has high energy content.

iii) It requires low investment.

iv) It does not increase the CO_2 contents in the atmosphere.

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L-43 Biofuels & Biofertilizers

Type of Biofuels:

1. Biohydrogen - is produced by anaerobic fermentation and by 'Photolysis' of water.

2. Biogas - is a gaseous bio fuel which is produced by the anaerobic degradation of organic matter.

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L-43 Biofuels & Biofertilizers

Type of Biofuels:

Constituent of Biogas	%
CH_4	63
CO_2	30
N_2	4
H_2S	1
H_2 O_2 CO etc.	Traces

- It is used for lightning and cooking purpose in rural area.

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L-43 Biofuels & Biofertilizers

3. Bio diesel –

- **Is a diesel like liquid obtained from**
- **materials of biological origin like**
- **liquids accumulated in plants and algae**
- **or from hydrocarbons produced by some plants and algae.**

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L-43 Biofuels & Biofertilizers

4. Bio ethanol –

- It is obtained from starch and sugar crops.
- It is used as fuel after blending with petrol.

Rap seed oil a substitute for Diesel -

- Rap seed oil has similar physical and chemical properties like diesel and hence
- it is called Bio diesel.

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L-43 Biofuels & Biofertilizers

The advantages of using rap seed oil as a biofuel –

- I t is 98% bio degradable.
- It is non-toxic.
- The raw material is renewable.

- Its contribution to green house effect is less than that of diesel.
- Energy yield is high.

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L-43 Biofuels & Biofertilizers

Production of Bio-Diesel – It has following steps:

- **Production of rapeseed oil by crushing of rap seeds.**
- **Heating of rapeseed oil with menthol at 50^0 C in presence of NaOH,**
- **So that diester is formed.**

$$\text{Rapeseed oil} + CH_3OH \xrightarrow{NaOH} \text{Glycerol} + \text{Diester}$$

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L-43 Biofuels & Biofertilizers

4.Algae as a source of energy:-

- **Algae are ‘renewable’ and economical source of energy.**
- **These are grown in a vessel called biocoil.**
- **These burn same as any other fuel like oil.**

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L-43 Biofuels & Biofertilizers

Advantages of using algae as a bio fuel are:-

- **Algae can be grown in dry lands and waste lands also.**
- **Solar energy is used for the growth of algae.**
- **Electricity produce is less costlier.**
- **It does not contribute to atmospheric pollution.**

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L-43 Biofuels & Biofertilizers

5. Bio-hydrogen as a source of energy:-

- In the presence of sun light,
- using 'hydrogenase' enzyme

- hydrogen can be produced from water
- by a process known as "Biophotolysis".

- Advantage of using hydrogen as a bio-fuel are –

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L-43 Biofuels & Biofertilizers

Advantage of using hydrogen as a bio-fuel are

- **Compared to coal and gasoline, it has high calorific value.**
- **On combustion, it does not produce pollutant gases.**
- **It can be used in fuel cells to produce electricity.**

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L-43 Biofuels & Biofertilizers

6. Methane as a source of energy:-

- **Hydrocarbons can be produced from 'unicellular algae',**
- **Botrycoccus braunii.**
- **It contains 75% hydrocarbon.**
- **Cultivation of this type algae is direct and renewable source of solar energy.**

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L-43 Biofuels & Biofertilizers

6. Methane as a source of energy:-

- **Methane is produced by**
- **‘Anaerobic degradation’ or from**
- **proteins, carbohydrates and lipids.**

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L-43 Biofuels & Biofertilizers

7. Water Hyacinth

as a source of energy:-

- **Water hyacinth is a 'water weed'**
- **which grows very rapidly on the surface of Ponds.**

- **It is sun dried , crushed and**
- **treated with NaOH in**
- **presence of Enzyme (klebseills Oxytoca) at high temperature.**

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L-43 Biofuels & Biofertilizers

- Fermentation process leads to the
- formation of butanediol
- which is recovered by distillation.
- Butandiol has a high ‘octane number’
- so it can be used to improve the octane number.

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L-43 Biofuels & Biofertilizers

BIO FERTILIZERS

- **Bio-fertilizers are 'bio-logically active products.'**

- **Bio-fertilizers are microbial inoculants of**
- **bacteria, algae and fungi**

- **that enrich the nutrient quality of soil.**

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L-43 Biofuels & Biofertilizers

BIO FERTILIZERS

- **Bio-fertilizers do ‘Symbiosis’ with plants means**
- **both get benefited from each other.**

- **Bio-fertilizers are**

- **environment friendly fertilizers.**

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L-43 Biofuels & Biofertilizers

The advantages of using bio-fertilizers are:-

- **Plant nutrition.**
- **Disease resistance and increased crop productivity.**

- **Tolerance to adverse soil and**
- **The low cost and eco friendly nature.**
- **These decrease the salinity of the soil.**

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L-43 Biofuels & Biofertilizers

The disadvantages of using bio-fertilizers are:-

- **These do not show immediate and extraordinary response.**
- **The amount of nutrients provided is not sufficient to meet**
- **the total needs of crop for high yield**

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L-43 Biofuels & Biofertilizers

Some important bio-fertilizers are given below:-

1. **Symbiotic nitrogen fixers:**

- **Rhizobium species of bacteria are**
- **soil bacteria,**
- **capable of forming ‘root nodules’ in**
- **most leguminous plants like**
- **beans, peas, pulses.**

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L-43 Biofuels & Biofertilizers

- **These fix atmospheric nitrogen and not only**
- **increase the production of crops but**
- **also leave a fair amount of N_2 in soil.**
- **Different types of Rhizobia are used:**
- **R. leguminosarum**
- **R. Trifoli,**
- **R. Pahsiaoli,**
- **R. Melitolli.**

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L-43 Biofuels & Biofertilizers

2. A symbiotic nitrogen fixers : 'Azospirillum' and 'Azotobactor',

- **when applied to soil fix atmospheric nitrogen and make it**
- **available for Graminanceous crops like**
- **wheat, rice and sugarcane etc.**
- **They also synthesize growth promoting 'antibiotic substances' helpful for plants.**

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L-43 Biofuels & Biofertilizers

3) Algal fertilizers:

- Blue green algae (Cynobacteria) are photosynthetic organism which fix N_2 .
- Blue green algae produce nitrogenase and fixation of nitrogen occurs in specialized structures called 'heterocysts'.
- These algae can accumulate biomass.
- They give growth promoting substance to soil.
- They provide partial tolerance to pesticides.

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L-43 Biofuels & Biofertilizers

(4) Phosphate Solubilizers:

They convert insoluble inorganic phosphates into

- **soluble organic phosphate,**
- **which can be utilized by crop plants.**
  - ♦ **Some example of phosphate solubilizers are**
- **Thiobacillus,**
- **bacillus etc.**

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L-43 Biofuels & Biofertilizers

- **(5) Mycorrhiza:**
- **Mycorrhiza is a symbiotic association of fungi with roots of plants**
- **so that the nutrients absorbed from the soil by the fungus are**
- **released to the host cells and in turn,**
- **the fungus takes its nutrient requirement from the host.**

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L-43 Biofuels & Biofertilizers

- **Some Functions of Mycorrhiza-**
- **They convert non available phosphate in to an available form.**
- **Produce growth promoting substance and**
- **Protect crop against soil pathogens.**
- **Produce growth promoting substance**
- **They are used in many corps including pulses**

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L-43 Biofuels & Biofertilizers

- **(6) Green Manuring:**

Is a 'farming' practice in which

- **A leguminous plant is ploughed into the soil and then**
- **A non legume is grown and allowed to take benefit of already fixed nitrogen.**

- **In addition to nitrogen, green manures also provide organic matter, N,P,K etc. and**
- **minimize the number of pathogens in soil.**

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L-44 Biosurfactants &…

BIO SURFACTANTS

- **Surfactants (or surface active agents) have the ability to reduce the 'surface tensions'.**
- **The molecules are 'amphiphilic' in nature i.e.**
- **These have both 'hydrophilic' and 'hydrophobic' parts in the same molecule.**

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L-44 Biosurfactants &…

The important functions of surfactants are –

- Detergency, wetting,
- spreading, foaming,
- defoaming, emulsification and
- demulsification.

- surfactants are simple and complex lipids or lipid derivatives.

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L-44 Biosurfactants &…

Bio-surfactants and their generators are summarized below-

Bio-surfactants	Microbes producing them
Rhamnolipids	Anthrobacter pseudomonas
Mycolic & carboxylic acids	Nocardia Pseudomonas micrococus
Diglycerides	Mycobacterium Acinetobacter
Monoglycerides	Mycobacterium Acinetobacter
Diglycosyl diglycerides	Lactobacillus

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L-44 Biosurfactants &…

Chemical structure of bio-surfactants:

- **They have ‘hydrophilic’ and ‘hydrophobic’ parts in the same molecule.**
- **The hydrophobic parts may be saturated or saturated 10-12 carbon long chain**
- **which is covalently linked to the**
- **‘hydrophilic part’ ester or amide linkage.**

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L-44 Biosurfactants &…

Chemical structure of bio-surfactants:

- **The 'hydrophilic part' can be**
- **carboxylic group of fatty acids**
- **or mono, di and polysaccharides of glyco lipid bio-surfactants and**
- **the polar side chain peptide backbone of lipopeptide bio-surfactants.**

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L-44 Biosurfactants &…

The advantages of bio-surfactants are:

- **Lower toxicity**
- **Bio-degradability**
- **A wide variety of possible structure and**
- **Renewable**

The disadvantages of Bio-surfactants:-

- **The recovery of bio-surfactants from the**
- **Fermentation and purification is**
- **difficult and costly.**

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L-44 Biosurfactants &…

Application of Bio-surfactants:-

Bio-surfactants are used in number of industries such as

- **industrial cleaning,**
- **agriculture,**
- **building & construction,**
- **plastic and elastomers,**
- **foods and beverages,**
- **leather, metals, paper, petroleum etc.**
- **use of enzymes in detergents.**

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L-44 Biosurfactants &…

Use of enzymes in detergents-

- **Proteases, α-amylase,**
- **cellulase and lipases are**

important enzymes which are be used in detergents because these are

- **cost effective,**
- **safe to use and are**
- **able to perform their function in presence of**
- **ionic and non-ionic detergents,**
- **soaps, oxidants etc. at**
- **pH between 8 to 10.5.**

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L-44 Biosurfactants &…

The important function of enzymes in detergents are given below:

S.No.	Enzymes	Functions
1.	Proteases	To improve the efficiency of detergents for the removal of protein in blood stains, milk, grass etc.
2.	α-amylase	Used to digest dirt and stains
3.	Cellulases	Used for washing cotton fabrics. Thus washed fabrics look like a new fabric.
4.	Lipase	Used to digest lipid present in dirt and or stains.

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L-44 Biosurf.. & Biosensors

BIOSENSORS

Biosensors are combinations of

- **biochemistry,**
- **membrane technology and**
- **microelectronics**

which enable the signals produced by specific biochemical reactions to be

- **registered,**
- **quantified and**
- **recorded.**

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L-44 Biosurf.. & Biosensors

(BIOSENSORS) Definition:-

"An analytical tool or system

consisting of

- an immobilized biological material in intimate contact with a
- suitable transducer device

- which can convert a biochemical signal,
- into a quantifiable electrical signal".

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

Uses of Biosensors:-

(a) Human and animal diagnostics.

(b) Industrial process control

(c) Pollution monitoring and

(d) Detection of bacterial contamination and

(e) Presence of toxic gases.

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L-44 Biosurf.. & Biosensors

(BIOSENSORS)

Characters of Biosensor

(a) Sensitivity

(b) Safety

(c) Accuracy

(d) Speed

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L-44 Biosurf.. & Biosensors

(BIOSENSORS) Requirements of a Good Biosensor

- The device should be cheap, small, easy to use and durable.

If it has to be used within the body,

- it should be biocompatible and tiny.

- It should be highly specific for the analyte.

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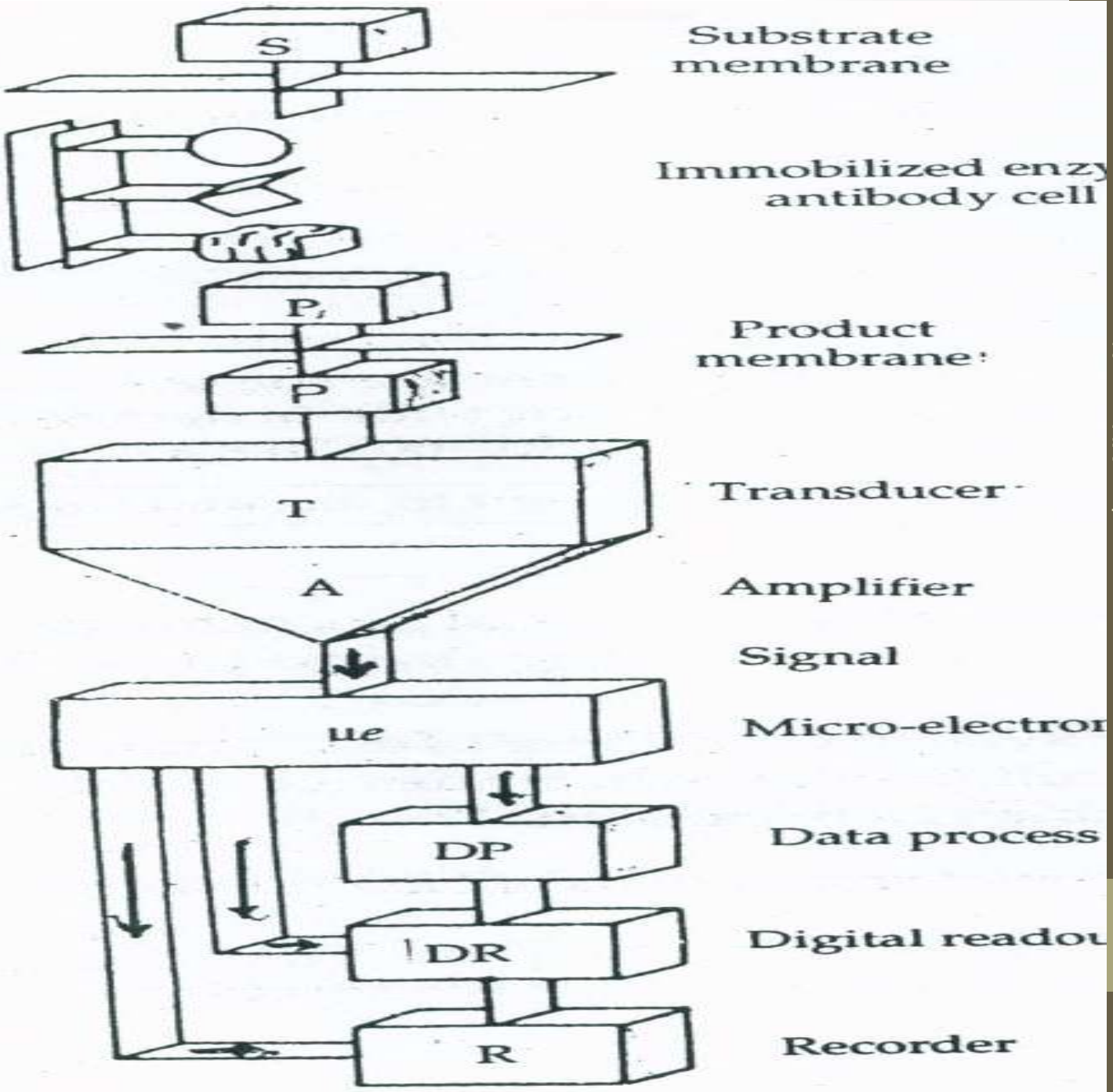

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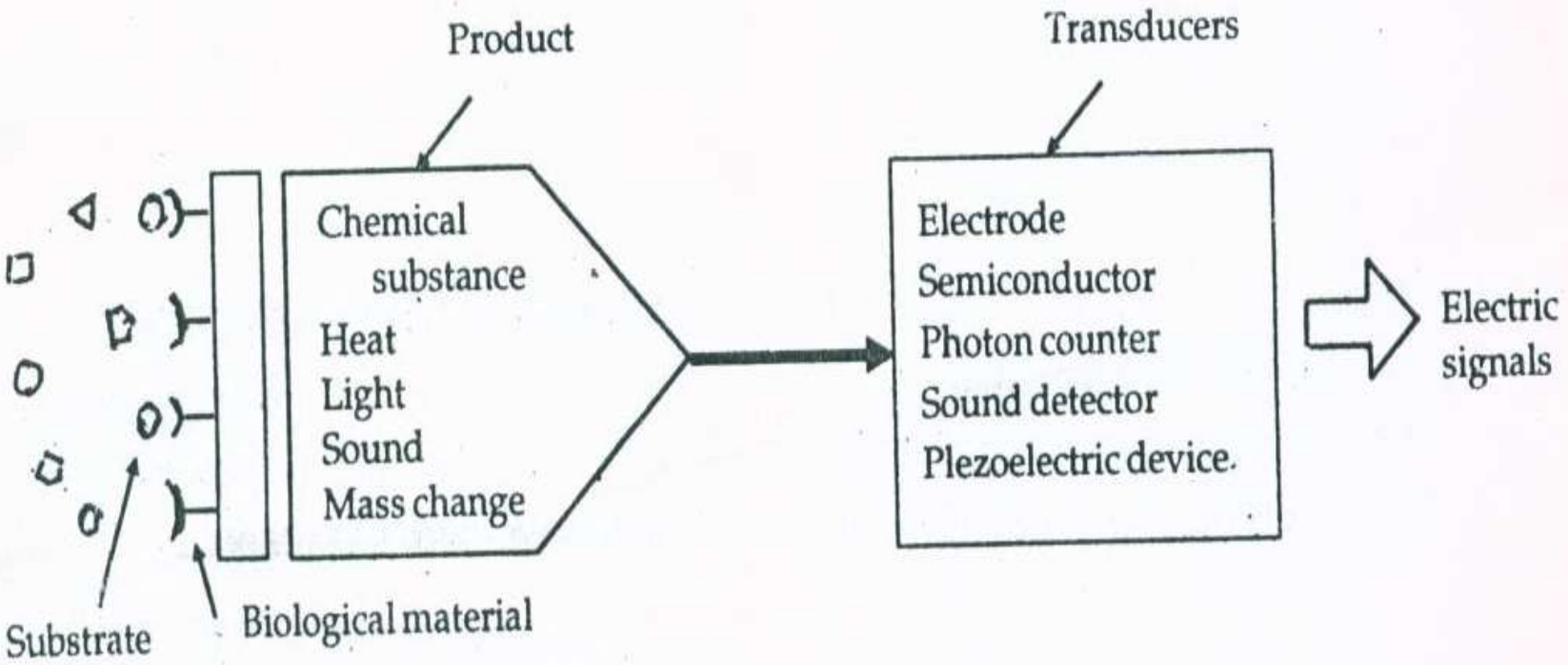

Fig. (a) Schematic of a biosensor. (b) Biosensor Principles.

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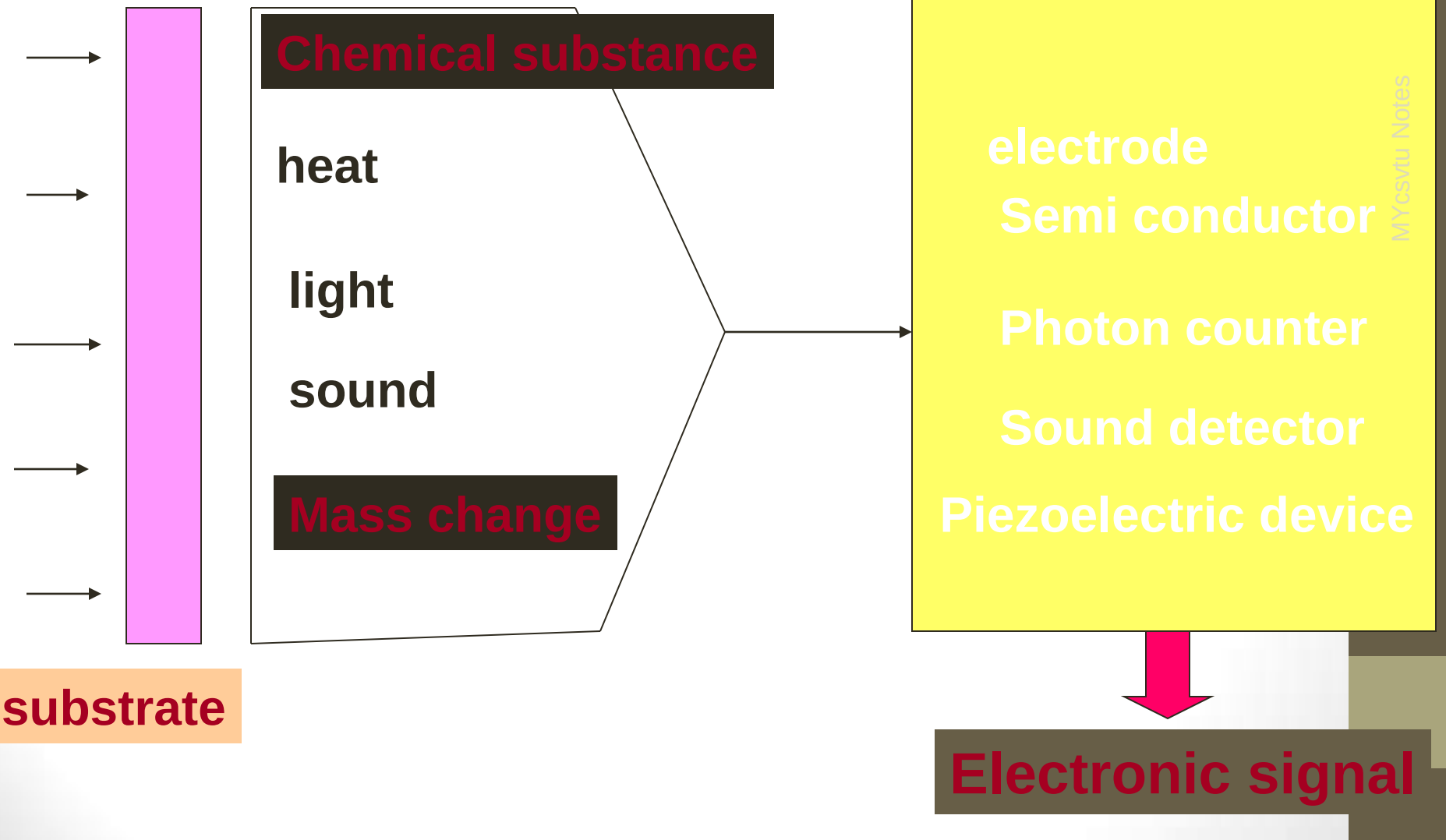
Principle of biosensor



L-44 Biosurf.. & Biosensors

(BIOSENSORS)

Main Components and Their Functions are Given Below-

- **Through the outer protective membrane,**
- **the substrate to be analyzed (S).**
- **And any co reactants diffuse.**
- **The membrane also selectively eliminate interfering species.**

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L-44 Biosurf.. & Biosensors

(BIOSENSORS)

The substrate then react with

- **the biological material like**

  enzyme,

  antibody or cell and

- **product (P) like**

  heat, gas,

  electrons, H+ is formed.

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

Or we can say that the

- **biological component of a biosensor**
- **specially recognizes the substrate and**
- **interacts with it and produce**
- **some physical changes**
- **detectable by the 'transducer'**

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L-44 Biosurf.. & Biosensors

(BIOSENSORS)

- **The product is detected at the 'transducer'.**
- **The signal processing equipment then**
- **converts the transducer signal**
- **into a suitable display.**

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

Classification of Biosensors:-

the biosensors can be classified into-

1. Calorimetric Biosensors:-

2. Electrochemical Type Biosensors:-

a) **Potentiometric Biosensor:-**
b) **Amperometric Biosensors:-**

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L-44 Biosurf.. & Biosensors

Classification of Biosensors:-

1. Calorimetric Biosensors:-
2. Electrochemical Type Biosensors:-
    a) Potentiometric Biosensor:-
    b) Amperometric Biosensors:-
3. Optic/Optoelectronic Biosensors:-
4. Acoustic Wave Biosensors:-
5. Bioaffinity Sensors
6. Whole Cell Biosensors:-

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

1.Calorimetric Biosensors:-

- **It measure the change in temperature of the solution and**
- **interpret it in terms of the concentration of the substrate in solution,**
- **separate thermistors are used to determine the temperature**
- **before and after the solution comes in contact**
- **with the biological component of the biosensors.**

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

2. Electrochemical Type Biosensors:-

a) Potentiometric Biosensor:-

- Ion – selective electrodes are used to convert
- the biological reactions into electronic signal.
- Many reactions generate or use up H+ ions
- which are detected and measured by
- glass electrodes.

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

b) Amperometric Biosensors:-

- Here a current is produced when
- potential is applied between two electrodes,
- the magnitude of current being proportional to
- the concentration of substrate.

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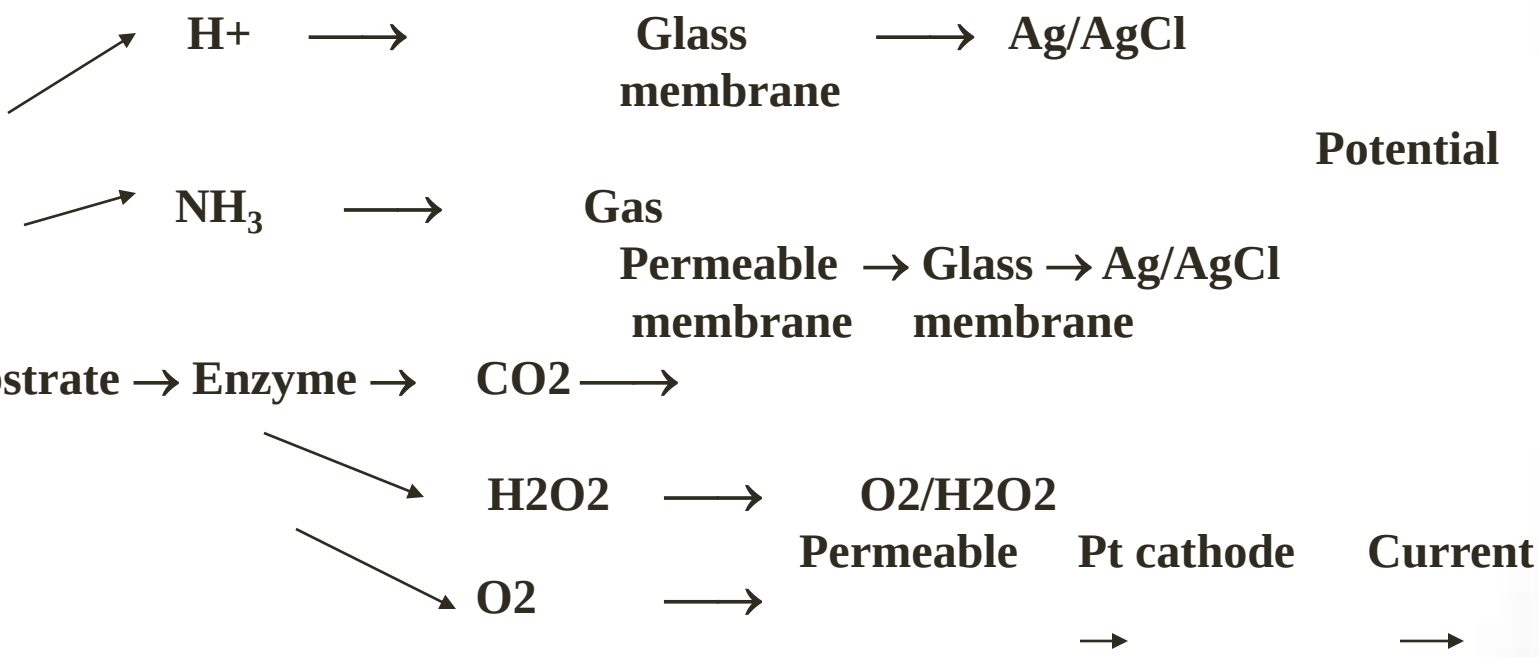
L-44 Biosurf.. & Biosensors

(BIOSENSORS)

A brief summery of electrochemical type biosensors are given below-



"Electrochemical type Biosensors"

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

3. Optic/Optoelectronic Biosensors:-

These are versatile and modern biosensors.

Based on the measurement of

- **light absorption,**
- **reflectance and**
- **fluorescence.**

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(**BIOSENSORS)**

4.Acoustic Wave Biosensors:-

- **The transducer is piezoelectric active Response**
- **out put depends on the**
- **change in mass or which gives surface of crystals**
- **variation in oscillating frequency.**

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L-44 Biosurf.. & Biosensors

(BIOSENSORS)

5. Bioaffinity Sensors:-

- **These are based on measuring the**
- **“antibody antigen interactions”.**

- **Labeled antibodies or antigens may be used in biosensor configurations based on**
- **‘enzyme-linked immunoassay’ (EIA).**

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

Example of Enzyme – Immunoassay Biosensor

Analyte	Enzyme label in conjugate	Transducer	Sensitivity
(i) Cancer diagnosis α-fetoprotein	Catalase	Amperometric	10-11 to 10-8 g/mL
(ii) Drugs Digoxin	Alkaline Phosphatase	Electrochemical	50×10^{-12} g/mL

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(**BIOSENSORS)**

6. Whole Cell Biosensors:-

- **These utilize immobilized whole cells**
- **or organelles instead of discrete enzyme.**

- **These have slow response and**

- **often react to broad spectrum of substrate.**

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L-44 Biosurf.. & Biosensors

(BIOSENSORS)

Practical Forms of Biosensors:- There are four types of Biosensors.

1. **Small Hand – Held Devices:-**
2. **The Laboratory Analyser:-**
3. **Flow Device:-**
4. **In Vivo Continuous or Implanted Monitor:-**

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

Practical Forms of Biosensors:-

There are four types.

1. **Small Hand – Held Devices:-**

Their design can be

- **dipstick pen - shape or**
- **a device having the size of**
- **a large hand – held calculator.**

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

Practical Forms of Biosensors:-

1. **Small Hand – Held Devices:-**

Requirements:-

- **Robustness,**
- **ease of operation by unskilled persons,**
- **small size,**
- **fast speed and an**
- **easily read display.**

Main Market:-

- **Monitoring 'blood glucose levels' in diabetics.**

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(**BIOSENSORS)**

2.The Laboratory Analyser:-

These are usually

- **small, discrete instruments,**
- **often transportable between**
- **laboratories and clinics.**

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L-44 Biosurf.. & Biosensors

(BIOSENSORS)

2.The Laboratory Analyser:-

Main Market:-

- **For glucose measurement in diabetic clinics.**

The uses are-

- **Faster analysis (no step required).**
- **No errors in pipetting and dilution.**

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L-44 Biosurf.. & Biosensors

(BIOSENSORS)

3. Flow Device:-

- **These are used for 'on line' monitoring of continuous processes.**

Example.

- **Large volume production in food processing,**
- **pollution monitoring,**
- **environment control and**
- **fermentation control.**

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

4.In Vivo Continuous or Implanted Monitor:-

Miniaturized implanted devices,

- **some incorporated in catheters,**
- **have been constructed and tested but the major difficulties of**
- **biocompatibility and**
- **sensor stability**

have not been successfully resolved.

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L-44 Biosurf.. & Biosensors

(BIOSENSORS)

Applications and Advantages of Biosensors:-

- **Clinical chemistry,**
- **Medicine and Health Care:–**
- **improve the efficiency of patient care-**

Specific examples are-

- **Single test with a small portable instrument such as**

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

- **such as glucose for diabetic monitoring,**
- **cholesterol for cardiovascular care etc.**

Multi test –

bench top instrument. Example.

- **Glucose and specific ions (such as potassium) for general health care ,**
- **creatinine and urea determination in urine (renal functions).**

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

Veterinary Agricultural and Food:-

1. Beverage (urine, spirits and beer improved production and quality control).
2. Food stuffs (contamination and toxins).
3. Fruit and vegetables (viral and fungal diagnosis).

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

4. **Dairy industry – milk (protein, fat, antibiotic, hormones).**
5. **Small and large animal care (fertility and infectious disease monitoring).**

6. Fermentation Industries,

7.Pharmaceutical Production:-

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

The uses are-

- **Biosensors give rapid responses**
- **which allow improved feedback control.**
- **It has a long lifetime**
- **which release technical staff for other duties**

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L-44 Biosurf.. & Biosensors

(BIOSENSORS)

- **Rapid sampling and rejection of below standard raw materials and**
- **low cost monitoring of stored products and raw materials.**
- **No interference with the process stream.**
- **Access to remote environments.**

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L-44 Biosurf.. & Biosensors

(**BIOSENSORS)**

Environmental Control and Pollution Monitoring:-

- **to combat the increasing number of pollutants**
- **in the ground water systems and hence into drinking water.**

Ex. Pesticide monitoring.

- **Detection of toxic gases including chemical warfare agents.**
- **Detection of BOD, COD etc.**

Sports:-

To detect fatigue by measuring levels of lactic acid and ammonia in sweat.

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L-45 Biochips & Bioreactors

BIO-CHIPS OR BIOLOGICAL COMPUTERS

'Biological computers' or 'biochips'

are 'hybrid machine' that would blend the organic and the electronic in a 'single machine'.

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L-45 Biochips & Bioreactors

BIO-CHIPS OR BIOLOGICALCOMPUTERS

- **Bio-chip production requires**
- **zero gravity conditions to**
- **achieve the proper**
- **quality and uniformity**
- **necessary for reliable operation.**

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L-45 Biochips & Bioreactors

The advantages of Bio-chips or Bio-molecular computers:

- **Storage of much more information in a much smaller space.**
- **It is expected that a single biochip could hold a**
- **billion times more information than**
- **a current silicon wafers.**

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L-45 Biochips & Bioreactors

- Heat production would be minimum.

- Manufacturing and operating costs would be low.
- Biochips are expected to be capable of

- parallel information processing in a network rather
- than working in linear mode.

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L-45 Biochips & Bioreactors

Compared to silicon chips,

- **biochips are expected to have reduce cross talk and**
- **more reliable intercommunication.**
- **Low power dissipation and**
- **faster switching time.**

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L-45 Biochips & Bioreactors

- **Potential applications of Biochips:-**
- **The bio-logical nature of bio-chips might**

- **allow their uses in medicine for implants in the body –**

- **To circumvent damage in the brain**
- **To regulate heart beat.**

- **Drug delivery and**
- **To control artificial limbs.**

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L-45 Biochips & Bioreactors

- **BIO REACTORS**
- **An apparatus in which bio-chemical enzymatic reactions are carried out is called as 'bio-reactors'.**

- **The main components of typical bio-reactor are:**
- **Stainless steel or copper tank.**
- **Provision for stirring either by mechanical agitation.**

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L-45 Biochips & Bioreactors

- **Provision at the top for**
- **charging the reactor with substrate and**
- **micro organism.**

- **Inlet at the bottom for**
- **steam for sterilization and**

- **Sensors for monitoring and**
- **regulation of reaction condition.**

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L-45 Biochips & Bioreactors

Types of Bio-reactors:

- **Mainly five types of bio-reactors are used:-**

1. **Batch Reactor –**
2. **Continuous –Flow stirred tank reactor**
3. **Continuous - Flow stirred tank reactor with ultra filtration**
4. **Plug – Flow Reactors**
5. **Fluidized – bed Reactors**

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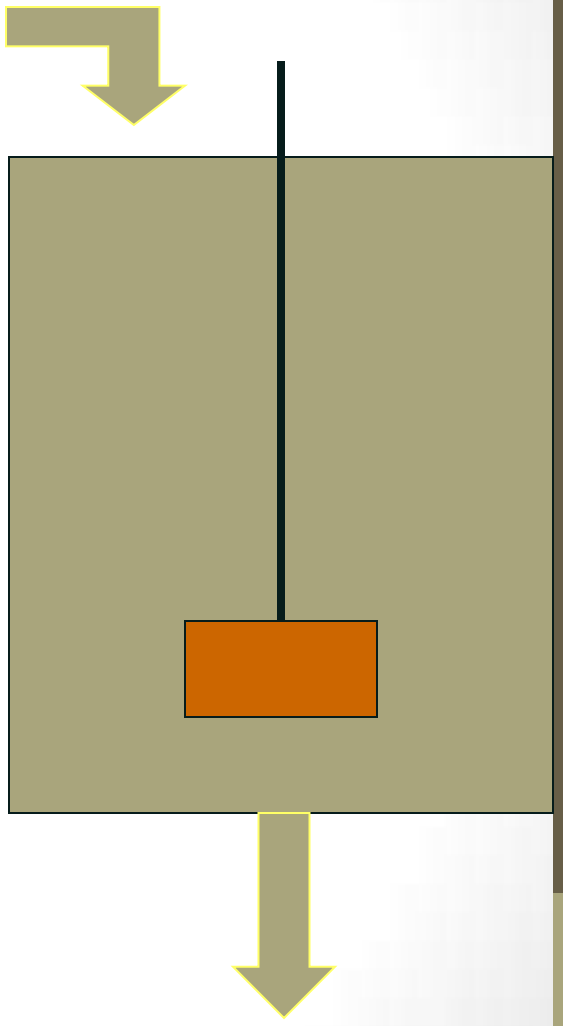
L-45 Biochips & Bioreactors

1. **Batch Reactor –**

- **They are used with free enzymes.**
- **In them high viscosity or insoluble subtracts can be used.**
- **For each batch, new enzyme is required.**
- **How ever substrate inhibition can be a problem.**



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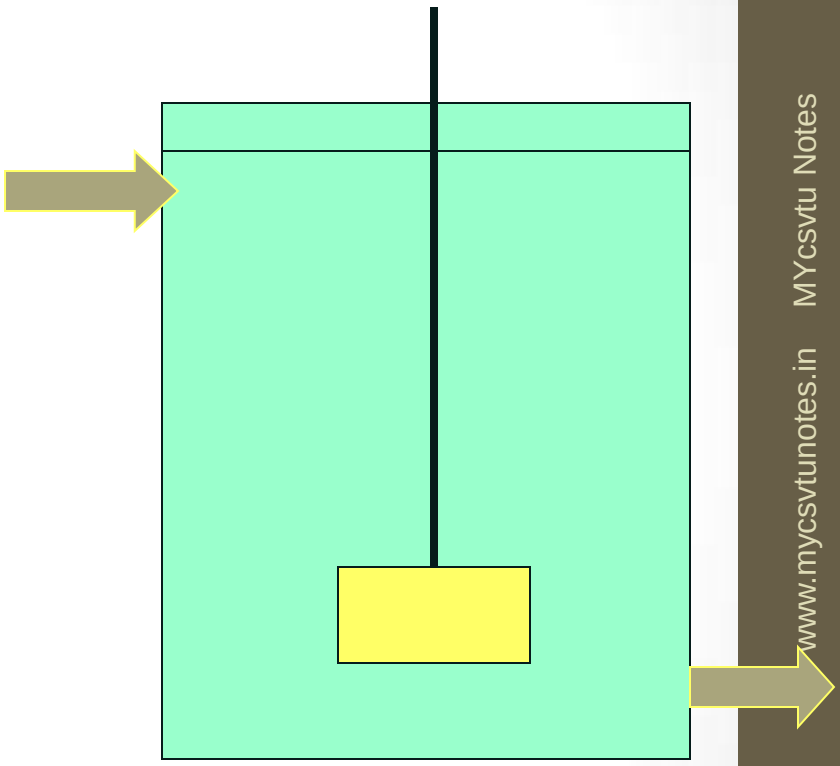
L-45 Biochips & Bioreactors

2. Continuous –Flow stirred tank reactor –

- **This can be used with free or immobilized enzymes.**
- **Addition or replacement of enzymes is simple.**
- **The control of pH is also simple**



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L-45 Biochips & Bioreactors

3. Continuous - Flow stirred tank reactor with ultra filtration –

- **They are like type (ii) discussed above. With following additional characters**

- **Poor enzymes stability over long term operation.**
- **Enzyme denatured or absorbed at membrane surface.**

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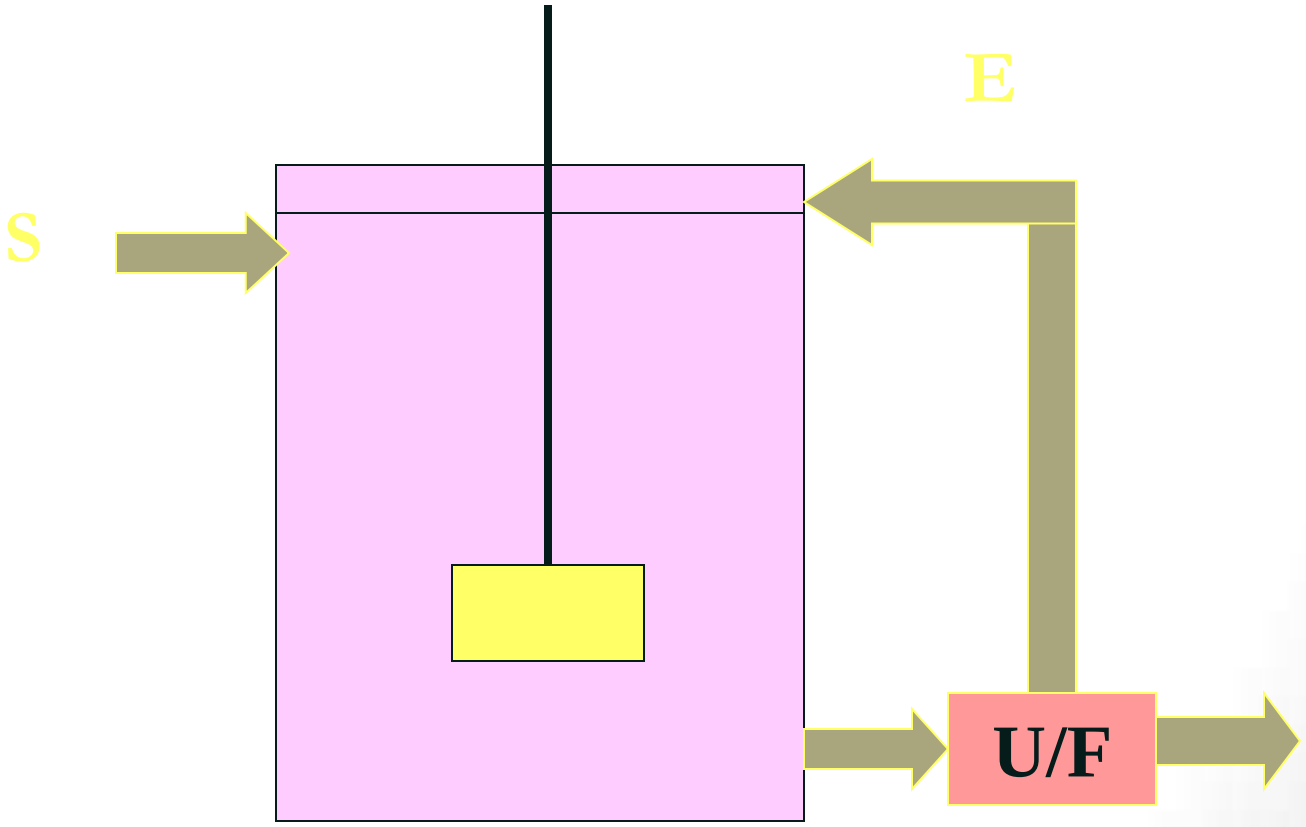
L-45 Biochips & Bioreactors

3. Continuous - Flow stirred tank reactor with ultra filtration



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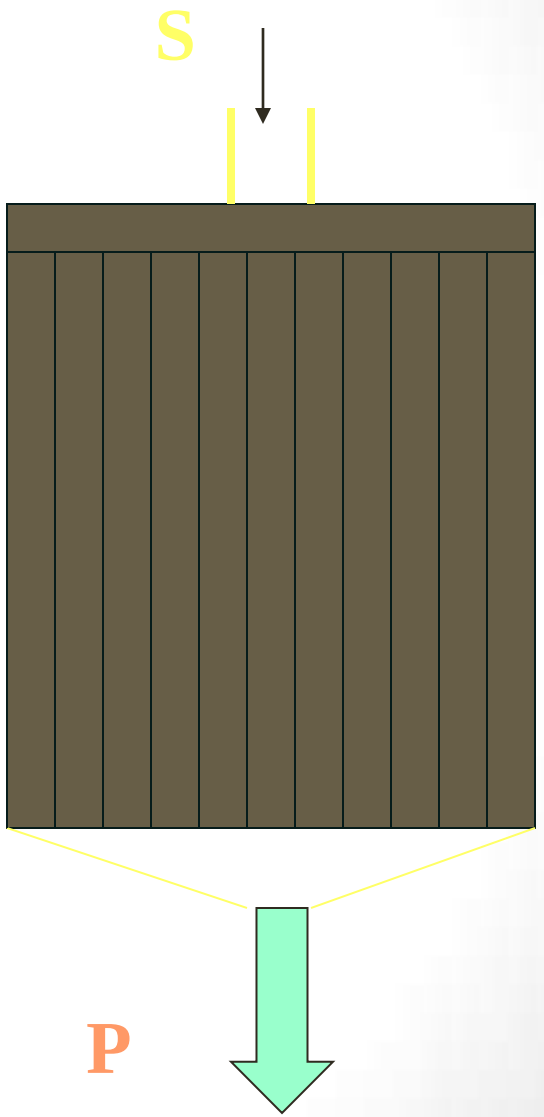
L-45 Biochips & Bioreactors

- **4. Plug – Flow Reactors**
  - **In them, insoluble enzyme particles are**
  - **packed in a column down which the substrate flow passes.**

Pros:

- **High conversion efficiency and**
- **Less problem with product inhibition.**



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L-45 Biochips & Bioreactors

4. Plug – Flow Reactors –Cons:

- **They are particularly susceptible to**
- **blocking and compression.**
- **They can not be used with insoluble or**
- **high viscosity substrate**

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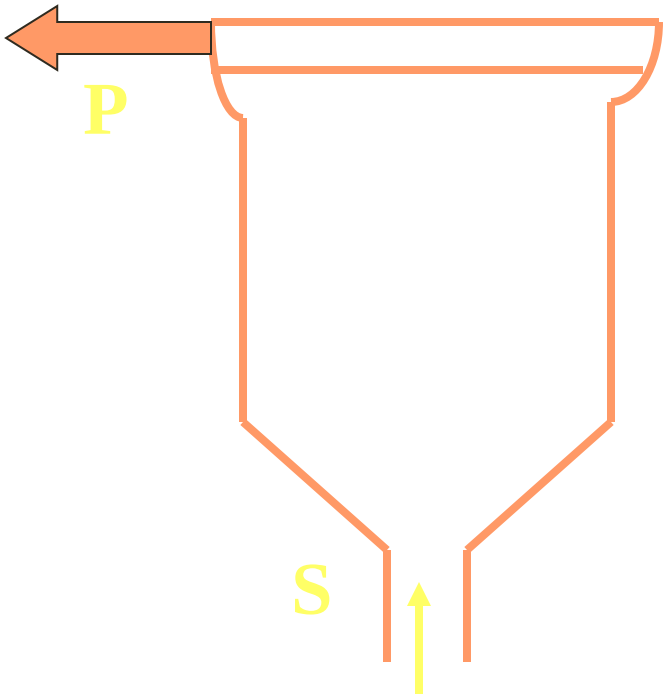
L-45 Biochips & Bioreactors

5. **Fluidized – bed Reactors – In them,**

- **immobilized enzyme is used and**
- **substrate stream is passed in an**
- **upward direction.**



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L-45 Biochips & Bioreactors

5. Fluidized – bed Reactors

Pros:

- **Insoluble and high viscosity subtracts can be used**
- **Better heat and mass transfer and**
- **Low pressure drop.**

Cons:

- **Large energy input to maintain a fluidized bed.**

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L-46 Pollution prevention in Tannery Ind..

Pollution Prevention Through Biotechnology:-

- **Biotechnology works for both**
- **clean – up/removal of pollutants**
- **as well as for prevention.**
- **Biotechnological options have proved to be not only effective to…**

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L-46 Pollution prevention in Tannery Ind..

Biotechnological options have proved to be not only effective to…

- **improve environment credentials of manufacturing,**
- **but higher yields, better quality of the products,**
- **advantages in cost,**
- **saving of energy and other resources have been achieved.**

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L-46 Pollution prevention in Tannery Ind..

- **Some industrial sectors, which have adopted bio-technological processes as an effective solution to prevent pollution are –**
- **Tannery industry.**
- **Paper and pulp industry.**
- **Pesticide industry.**
- **Food and allied industry.**

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L-46 Pollution prevention in Tannery Ind..

1.Tannery Industry:-

Biotechnology can play a significant role in tannery industry,

- **both in preventing generation of wastes and**
- **also in effective treatment of wastes**

- **un-hairing and degreasing can be done with the help of enzymes,**

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L-46 Pollution prevention in Tannery Ind..

1.Tannery Industry:-

- **avoiding chemicals like sulphides, alkylphenol ethoxylates etc.**
- **The use of enzymes can cut down processes like**
- **bating and**
- **the hide structure will remain least disturbed.**

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L-46 Pollution prevention in Tannery Ind..

- **Fat – digesting enzymes are used for degreasing and**
- **it can eliminate use of organic solvents and surfactants.**
- **Recovery of proteins and fats from wastes as bye – products.**

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L-46 Pollution prevention in Tannery Ind..

- **Fungi can be used for leaching out Cr from tannery effluents and**
- **to remove toxic tannins present in tannery effluents.**

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L-47 Pollution prevention in Paper & Pulp Ind.

Paper and Pulp Industry:-

- **Biotechnology has many contributions to offer to the modern pulp and paper industry.**

- **Micro – organisms, enzymes, and newer technologies are being applied at various stages.**

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L-47 Pollution prevention in Paper & Pulp Ind.

Some major applications areas are-

- **Biopulping --fungi used to**
- **degrade and reduce lignin contents of cellulose pulp.**
- **Mechanical/chemical pulping.**
- **Biobleaching --use of enzyme xylanase or**

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L-47 Pollution prevention in Paper & Pulp Ind.

- **fungi producing such enzymes to make**
- **pulp brighter instead of chemical bleaching.**
- **Ethanol production from 'sludge'.**
- **Growing yeasts or fungi on sulphite waste liquors.**
- **Discolouration of pulp mill waste liquors with the help of fungal biomass, or**

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L-47 Pollution prevention in Paper & Pulp Ind.

- degradation of chlorinated lignin **derivatives by white rot fungus.**
- Biological drinking of paper **i.e.**
- cellulase and hemicellulase **to unhook ink from paper**
- **and help its recycling.**

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L-47 Pollution prevention in Paper & Pulp Ind.

Advantages with biotechnological applications.

- **Reduced use of chemicals,**
- **reduced pollution problems,**
- **higher yields,**
- **stronger or better quality paper**

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L-48 Pollution prevention in Pesticide Ind.

Pesticide Industry:-

- **The tremendous diversity in chemistry of pesticides makes**
- **their detoxification process a difficult task.**
- **Manufacturing pesticides that are**
- **less persistent and more prone to biodegradation, …..**

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L-48 Pollution prevention in Pesticide Ind.

(Pesticide Industry)

- **manufacturing and using biopesticides which will have**
- **specificity of action and**
- **minimum environmental or biohazard, and ultimately aiming for**
- **resistance within the crops by**
- **use of genetic engineering**

are all part of clean technology programs.

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L-48 Pollution prevention in Pesticide Ind.

But till we get succeed in

- **prevention of pollution,**
- **treatment technologies to**
- **efficiently eliminate pollutants**

needs to be seriously examined.

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L-48 Pollution prevention in Pesticide Ind.

- Pesticide industry waste – waters,
- residual pesticides in fields and
- contaminated ground water are required

to be decontaminated of pesticides and their intermediates.

- Microorganisms possessing
- manipulated genes or enzymes with
- specific degradative capacity may be used for this purpose.

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L-48 Pollution prevention in Pesticide Ind.

There are various reports of use of enzymes like

- **esterase,**
- **phosphatase,**
- **alkylsulphatase,**
- **oxygenase etc.**

for detoxification of pesticides.

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L-48 Pollution prevention in Pesticide Ind.

Organisms like

- **Pseudomonas,**
- **Candida tropicalis,**
- **Aspergillus niger**

can degrade herbicide of

- **chlorobenzoate class.**

Though applications are limited today,
the potential of Biotechnology is proven.

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L-49 Pollution prevention in Food & Allied Industries.

Food And Allied Industries:-

Wastes from this industries have

- **high suspended solids,**
- **high BOD & COD,**
- **no toxic matter.**

Effluents are generally

- **rich in carbohydrates and**
- **deficient in nitrogen.**

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L-49 Pollution prevention in Food & Allied Industries.

- **BOD and COD reduction is usually done**
- **along with generation of energy in the**
- **form of biogas and ethanol.**
- **Many new efficient biomethanisation**
- **reactors are available and**

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L-49 Pollution prevention in Food & Allied Industries.

- **bioconversions of wastes to other**
- **chemical products is also possible.**

Solid wastes is a problem in

- **fruit,**
- **vegetable,**
- **meat and**
- **poultry**

processing industries.

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L-49 Pollution prevention in Food & Allied Industries.

- Component separation and
- recovery of some useful products is common for
- meat and poultry processing industries
- which have slaughter houses,

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L-49 Pollution prevention in Food & Allied Industries.

- **while solid wastes of fruit and vegetable processing industries are**
- **suitable for ethanol production or**
- **biomass production.**

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