UNIT 5

BIOTECHNOLOGY

- BIOTECHNOLGY is the industrial use of **micro organism , living animal & plant cells.**

- Micro organism → Product

Process

Definition

- **“ Biotechnology is the application of biochemistry, biology, microbiology & chemical engineering to industrial process.”**

- SO WAY CAN SAY-

‘Biotechnology is a multidisciplinary science” .

- Biofuel .
- Biofertilizer.
- Biosurfactants.
- Biochips.
- Biosensors.

- **BIOFUELS (IMP)**

- The biofuels are **biologically produced fuels.**

Characters of biofuels

- They derived from **biomass.**
- Which is **renewable .**
- Low cost.
- Easily available.

- Biofuels emit low CO_2 .
- Pollutants like SO_2 ,NOx are not produced.

Undesirable characters of biofuel

- Very large scale production is required.
- Low value of product.
- Low profit.

- Biomass – “**living matter used as a source of energy.**”

Biomass for energy production

- **During photosynthesis the solar energy is converted in to biomass which is stored & used as a fuel.**

- Biomass is nothing but **living matter.**

or

- Living matter's **residues** which are used as a source of energy.

Sources of biomass

- Land crops like –

- Eucalyptus,
- Maize,
- sugarcane &
- pine tree.

- Aquatic plants like-
- Water weeds.
- Algae.

- Wastes such as-
- Domestic sewage
- Wood
- Crop residues.

Advantages of using biomass as a fuel

- Biomass is renewable.
- Can be stored.
- Having high calorific value.
- It requires low investment.
- Less pollution.

Energy Crops

- Are those plants which uses **Solar energy.**
- And converts CO2 into the **Biomass.**
- Can be used as a **source of energy.**

Some plant species which can utilise as a fuel

Plant species	Nature of biomass	Mode of energy use
Algae-chalamydomonas, clostridium	hydrogen	biohydrogen
Crop residues, Swage, Animal refuge	wastes	biogas
Sugar cane	sugar	bioethanol
Algae, euphorbia	hydrocarbon	biodiesel

Types of biofuel

1. **Bio hydrogen-**

is produced by **anaerobic** fermentation.

also produced by **photolysis of water.**

2. **Bio gas-**

is a gaseous biofuel which is produced by the anaerobic degradation.

It is used for lighting & cocking purpose.

Biogas	CH_4	CO_2	N_2	H_2S	H_2 & CO
%	63	30	4	1	Trace

- **3. Bio diesel-**

  is a diesel like liquid obtained from biological plants.

- **4. Bioethanol-**

  is obtained from starch & sugar.

It is used as fuel after blending with petrol.

Algae as a source of energy-

- Algae are **renewable.**
- **Economical** source of energy.
- They burnt with same as fuel like **Oil.**

Advantages

- They can be grown in dry land area.
- Do not contribute pollution.
- Easily available.

Bio hydrogen as a source of energy

- In presence of sunlight using hydrogenease enzyme H2 can be produced.

- And form water by process known as **Photolysis.**

Advantages

- It has high calorific value.
- It does not produce pollutants .
- Used in production of electricity.

Methane as a source of energy

- Hydrocarbons can be produced from **Unicellular algae.**
- It have 75 % HC in it.
- Renewable.
- Direct source of energy.

Water hyacinth as a source of energy-

- Water hyacinth is a water weed.
- Which grow on surface of pond.
- It gives Butandiol , which has high Octane number.

Bio-fertilizers

- They are biologically active products.
- They are Symbiosis with plants.
- They are environment friendly fertilizers.

Advantages

- Plant nutrition.
- Disease resistance and increased crop productivity.
- Low cost.

- Eco friendly nature.
- They decrease the salinity of soil.

Disadvantages

- They do not give immediate response.
- The nutrients produced are not enough.

Some Important Fertilizers are -

1. Symbiotic Nitrogen Fixers-

- Rhizobium species of bacteria are soil bacteria .
- Capable of forming **root nodules.**
- Ex. Plants like- peas, beans, pulses.

- They fix the atmospheric nitrogen.
- And leave a fair amount of N2 in soil.

Types of Rhizobia are –

- R- Leguminosarum
- R- Trifoli
- R- Phaseoli
- R- melitolli

2. Asymbiotic Nitrogen Fixers

- Azospirillum and Azotobacter when applied to soil fix atmospheric nitrogen.
- And make it available for crops like wheat, rice etc.

- They also produce growth promoting antibiotic substance.

3. Algal Fertilizers-

- Blue green algae produce nitrogenase.
- They give growth promoting substance to soil.

- These algae can accumulate biomass.
- They provide partial tolerance to pesticides.

3. Phosphate Solubilizers (PSB)-

- They convert insoluble phosphates into soluble phosphates.
- Exp. Thiobacillus, Bacillus.

4. Mycorrhiza

- It is the symbiotic association of fungi and root.
- They convert non available phosphate into available form.

- They protect crop against pathogens.
- Produce growth promoting substances.

Green Manuring

- It is a farming practice.
- In which a leguminous plant is ploughed into the soil and then a non lagume is grown.
- It takes benefits of already fixed N2.

- Green Manure also give N,P,K.
- They reduce pathogens of soil.

Biosurfactants

- Surfactants means surface active agents.

- Surfactants have ability to reduce the

Surface Tension

- They are amphiphilic in nature.

- Amphiphilic means

  “ they have both hydrophilic & hydrophobic parts in same molecule.”

- Functions of surfactants –
- Detergency
- Wetting
- Spreading

- Foaming.
- Defoaming
- Emulsification

- The surfactants which are produced by microorganism are termed as biosurfactants.

biosurfactants	rhamnolipids	diglycerids	monoglycerides
Microbes producing them are-	Arthrobacter, Pseudomonas.	Nocardia, Pseudomonas micrococus	Microbacterium

Advantages

- Lower toxicity.
- Biodegradable.
- Renewable.

Disadvantage

- The recovery of biosurfactants from the fermentation & purification is difficult.

Application of biosurfactants-

- In industrial cleaning ,
- Agriculture,
- Building & construction
- Plastics & elastomers

- Food & beverages,
- Paper,
- Petroleum etc.

- Use of enzymes in **detergents.**

enzymes	function
1. Proteases	To improve efficiency of detergents
2. Amylase	Used to digest dirt & stain
3. Cellulases	Used for washing cotton fabric
4. Lipase	Used to digest lipids present in dirt & stain.

Biochips

- Also called **Biological Computers.**

- Biochips are **Hybrid machines .**
- **That would blend the organic & the electronic in a single machine.**

Advantages

- Storage of much more information in a much smaller space.
- Heat production in biomolecular computers would be minium.

- Manufacturing & operating costs are expected to be low.

- Compared to silicon chips, biochips are more reliable chips.

- Faster switching time.

Application

- The biological nature of biochips might allow their development in medicine for implants in the body-
- To regulate the heart beat.
- To circumvent damage in the brain.

- To control artificial limbs.
- To control drug delivery.

Bioreactor

- An apparatus in which **biochemical enzymatic reaction** are carried out is called **bioreactor.**

Main components of typical bioreactor

- Stainless steel or copper tank.
- Provision for **stirring** either by mechanical agitation.
- Provision at the top for **charging** the reactor with substrate & micro organism.

- Inlet at bottom for **steam.**

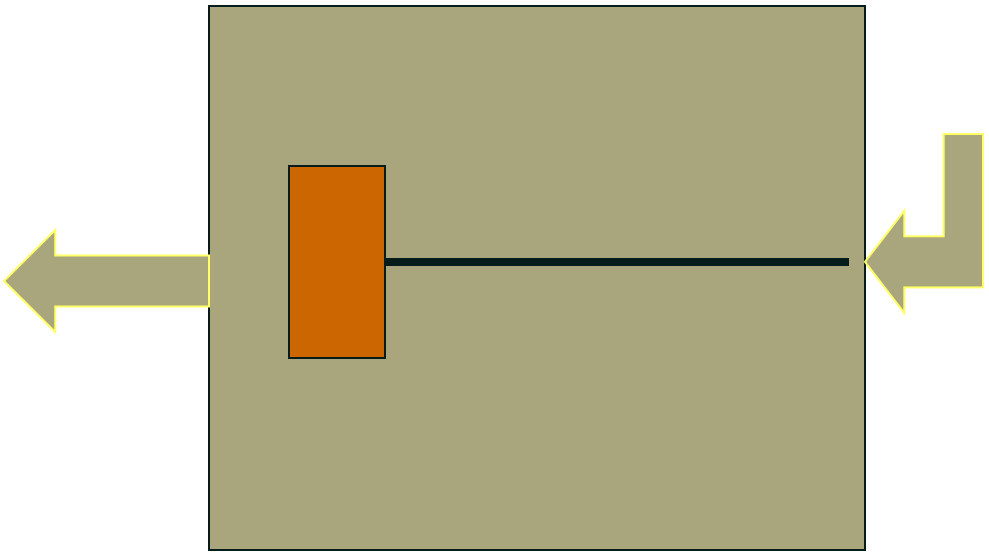
- **Sensors** for monitoring & regulating of reaction.

Types of bioreactor

- **Mainly 5 types of bioreactors are used-**
- Batch reactor.
- Continuous flow stirred tank reactor.
- Continuous flow stirred reactor with ultrafiltration.
- Plug flow reactor.
- Fluidized bed reactor.

- **Batch reactor-**

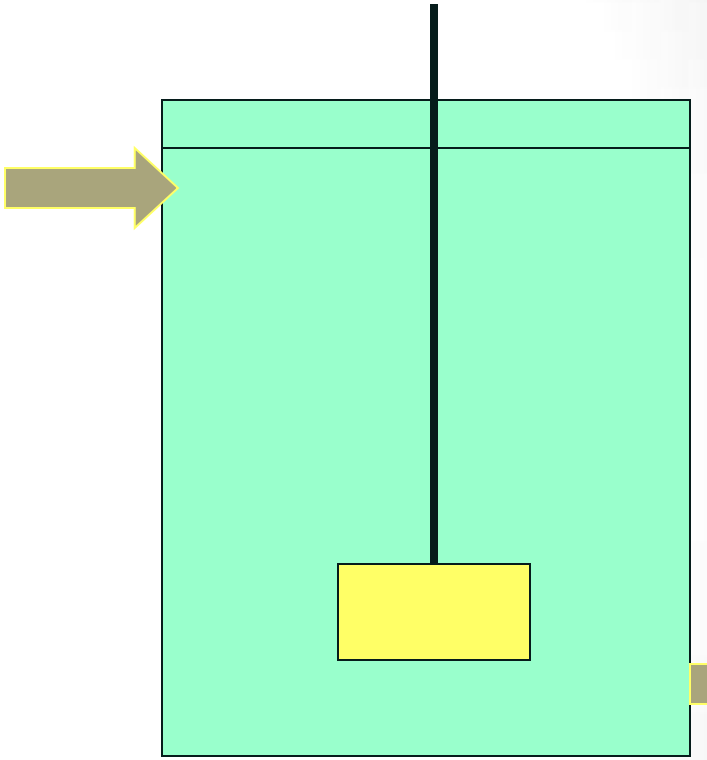
- They are used with free enzymes.
- In them insoluble substrates can be used.
- For each batch new enzyme is required.



- **Continuous flow stirred tank reactor-**
- This can be used with free or immobilized enzymes.
- Addition or replacement of enzymes is simple.

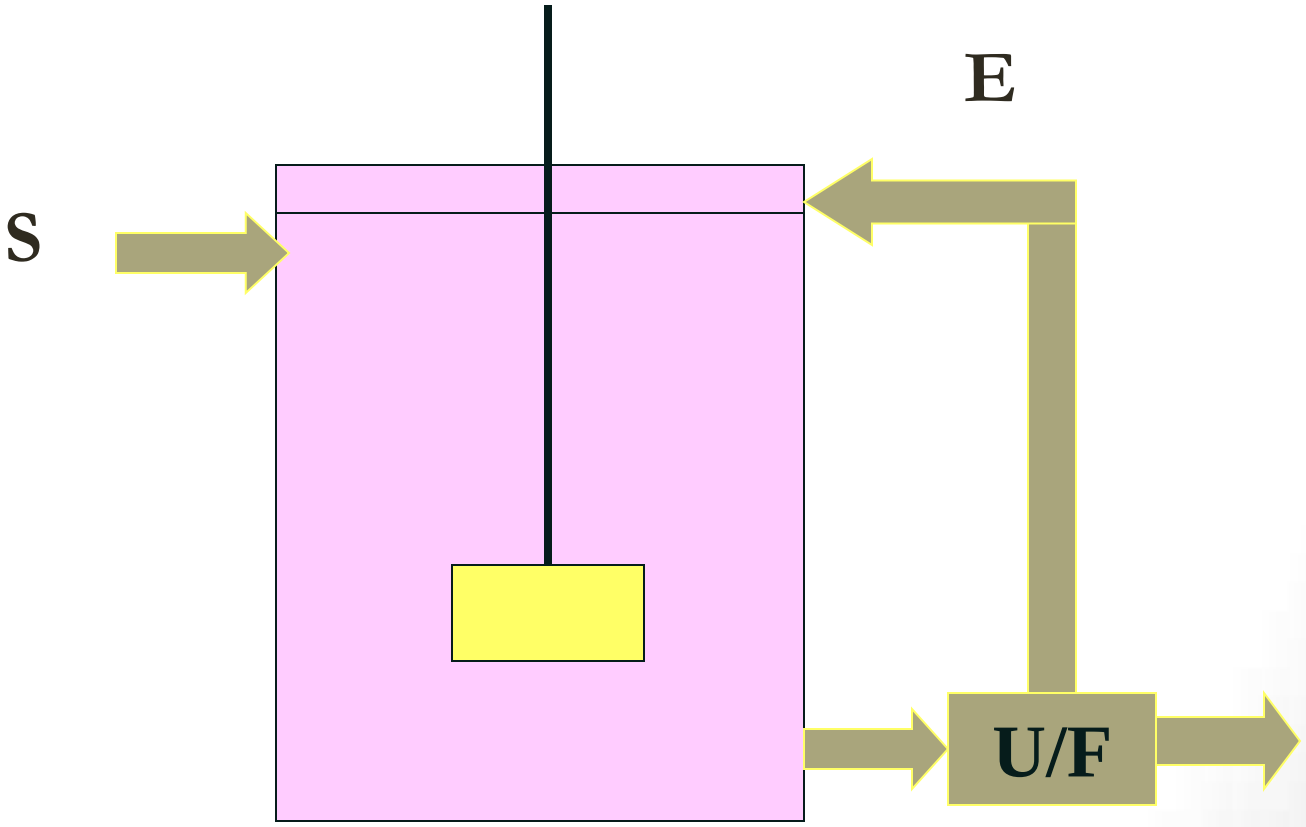
- The control of pH is also simple.

2. Continuous –Flow stirred tank reactor –



- **Continuous flow stirred reactor with ultrafiltration-**
- They are same as **continuous flow reactor.**
- Poor enzyme stability over long term operation.
- Enzyme denatured or absorbed at membrane surface.

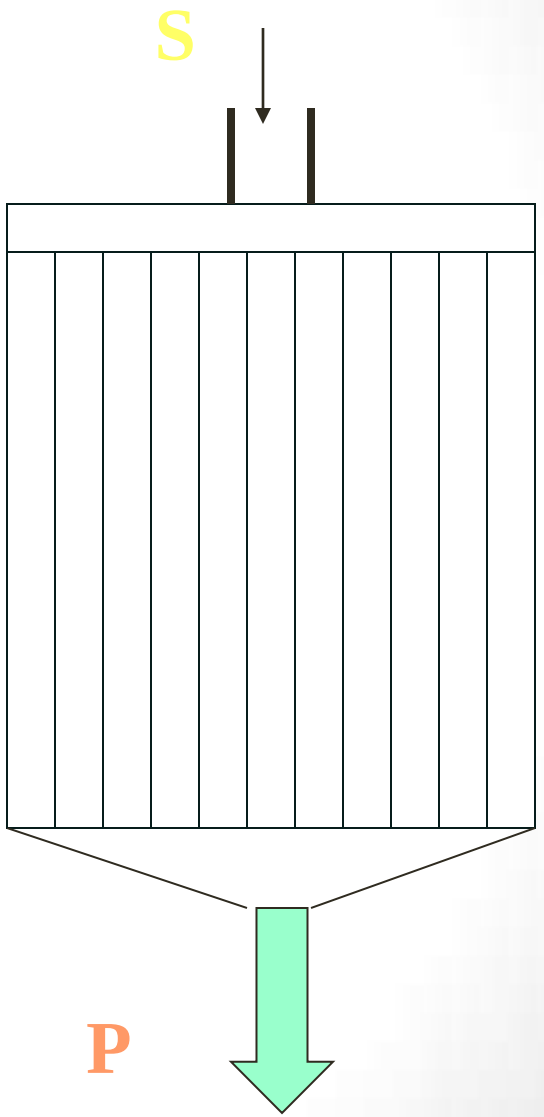
3. Continuous - Flow stirred tank reactor with ultra filtration



- **Plug flow reactors-**

- Insoluble enzyme particle are packed in a column drown which the substrate flow pass.

- **4. Plug – Flow Reactors**



Advantages

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

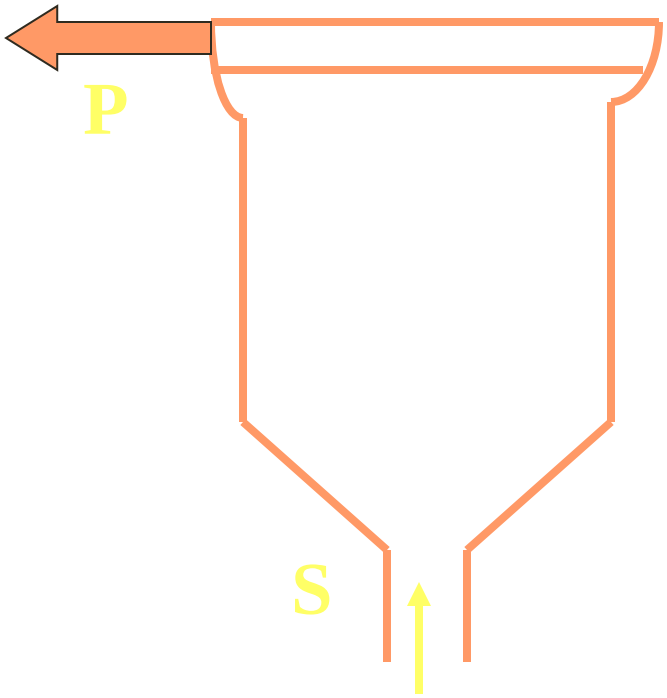
Disadvantages

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

- Fluidized bed reactor-

- In them immobilized enzyme is used & substrate stream is passed in an upward direction.

5. **Fluidized – bed Reactors –**



Advantage

- Insoluble & high viscosity substrates can be used.
- Better heat & mass transfer
- Low pressure drop.

Disadvantage

- Large energy input to maintain a fluidized.

Biosensors
(IMP)

- They are combinations of –

- **Biochemistry,**
- **membrane technology,**
- **Microelectronics.** Which enable the signals produced by specific biochemical reactions to be **registered, quantified & recorded.**

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 **quantified electrical signal.**

Advantages

- Human & animal diagnostics.
- Industrial process control.
- Pollution monitoring.
- Detection of toxic gases.
- Detection of bacterial contamination.

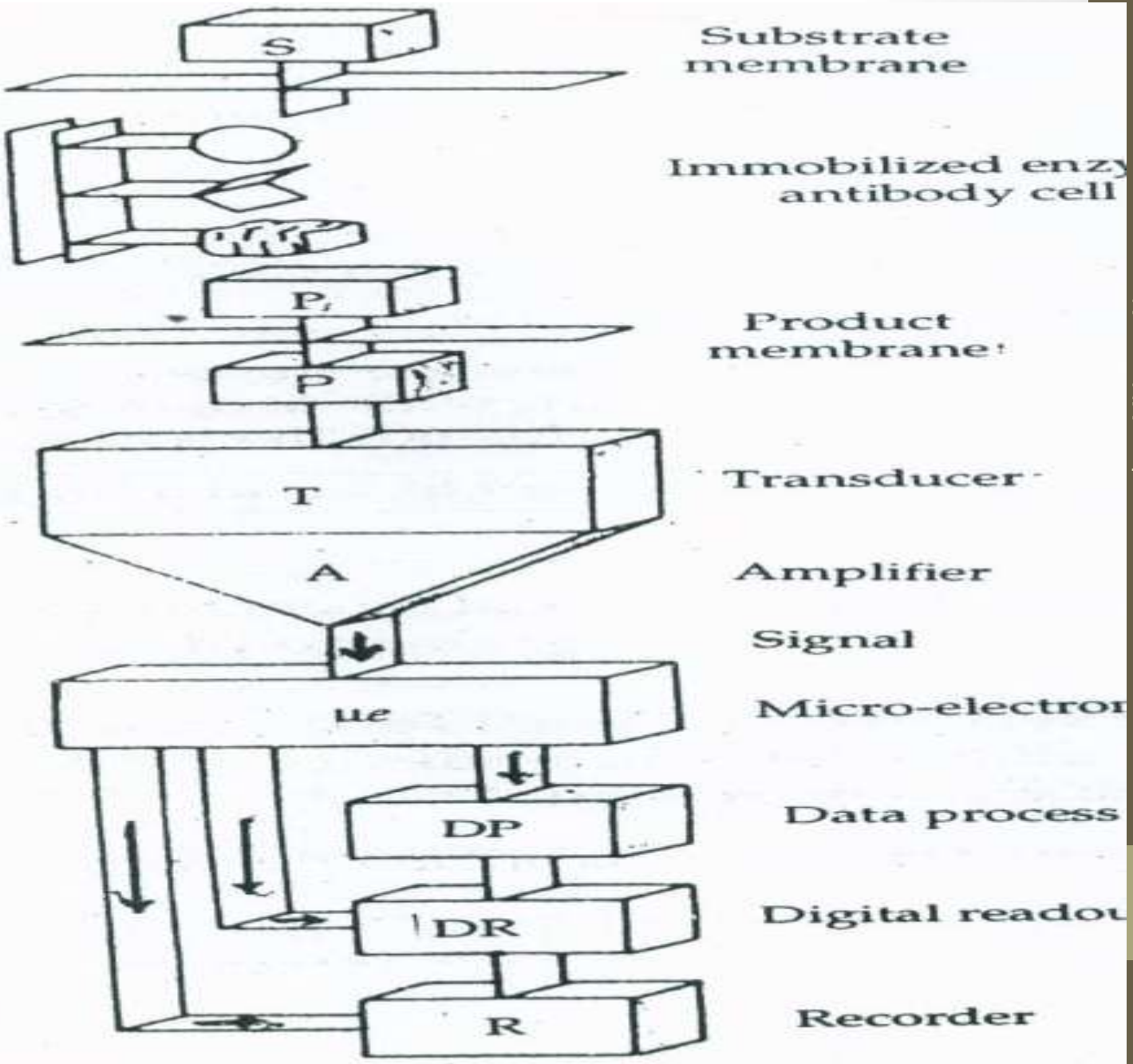
Characters of biosensors

- Sensitivity
- Safety
- Accuracy
- Speed.

- **Requirements of good biosensors-**
- The device should be cheap, small,easy to use & durable.
- It should be biocompatible.
- It should tiny.

Main components & functions

- (1) through the outer protective membrane the substrate to be analysed (s).
- And any co reactants diffuse.
- The membrane also selectively eliminate interfering species.



- (2) The substrate then react with the biological material like-
- Enzyme, antibody or cell.

- And react with product (p) like-

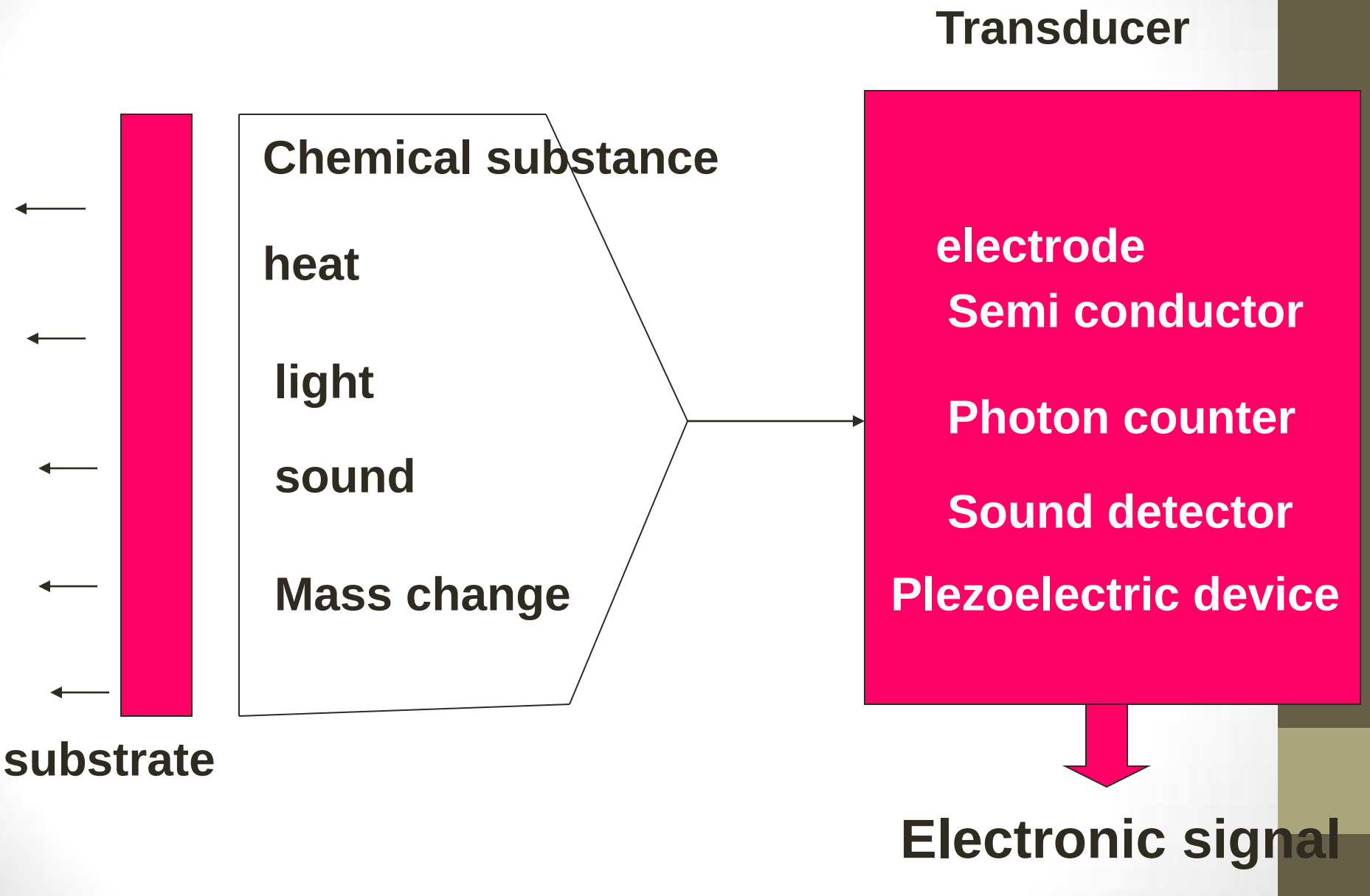
- Heat, gas, electrons, H+ is formed.

- (3) the biological component of a biosensors specially recognizes the substrate.

- and interacts with it in such a manner so as to produce some physical changes detectable by the **transducer.**

- (4) the product is detected at the transducer.
- (5) the signal processing equipment then convert the transducer signal into a suitable display.

Principle of biosensor



Classification of biosensors

1. Calorimetric biosensors.
2. Electrochemical type biosensors.
3. Optic biosensors.
4. Acoustic biosensors.

Calorimetric biosensors

- It measures the change in temp.

Electrochemical biosensors

- They are of two types-
- (a) Potentiometric biosensors.
- (b) Amperometric biosensors.

A brief summery of electrochemical type biosensors are given below-

H+ ⟶ Glass membrane ⟶ Ag/AgCl

Potential

NH3 ⟶ Gas

Permeable → Glass membrane → Ag/AgCl membrane

- Substrate → Enzyme → CO2 ⟶
- membrane
- H2O2 ⟶ O2/H2O2
- Permeable ⟶ at cathode ⟶ Current
- O2 ⟶
- “Electrochemical type Biosensors”

Optic type biosensors

- They are modern biosensors.
- They based on the measurement of light absorption & reflection.

Acoustic types biosensors

- In such biosensors the transducer is of crystals type.

Application of biosensors

- (1) clinical chemistry, medicine & health care-

- **Single test with a small portable instrument such as Glucose for diabetic monitoring.**

- **(2) veterinary, Agriculture & food-**

- Beverages (wine, spirits production & control method.)
- Small & large animal care. (fertility & infection disease.)

- (3) Fermentation & pharmaceutical industries.
- (4) Environmental control.
- (5) Sports.

- **POLLUTION PREVENTION THROUGH BIOTECHNOLOGY (IMP)**

L-50 Pollution prevention in Tannery Ind..

- **Pollution Prevention Through Biotechnology:-**
- **Biotechnology work for both clean – up/removal of pollutants as well as prevention.**
- **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.**

L-50 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.

TANNERY INDUSTRY

- **Tannery Industry:-** Biotechnology can play a significant role in tannery industry, both in preventing generation of wastes and also in effective treatment of waters **un-hairing** and **degreasing** can be done with the help of enzymes, 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.

- The use of fat – digesting enzymes for degreasing is beneficial as it can eliminate use of organic solvents and surfactants.

- This helps for recovery of proteins and fats from wastes as bye – products. Fungi can be used for leaching out **chromium** from tannery effluents and to remove toxic tannins present in tannery effluents.

PAPER AND PULP INDUSTRY

- 1) **Biopulping** (Fungi used to degrade & reduce lignin contents of cellulose pulp).
- 2) Mechanical or chemical pulping.
- 3) **Biobleaching** (Use of enzyme **Xylanase** or fungi make the pulp **brighter).**

- 4) Ethanol production from **Sludge.**
- 5) **Discoloration** of pulp mill waste liquors with the help of fungal **boimass.**
- 6) **Degradation** of chlorinated lignin derivatives by **white rot fungus**.

- 7) **Biological drinking of paper.**

  (celluloses & hemicellulases to unhook ink from paper) and helps its recycling.

PESTICIDE INDUSTRY

- 1) Manufacturing pesticides that are less persistent & more pone to biodegradation.

- 2) Manufacturing & using less biohazards

  are possible with biotechnology.

- 3) Waste water, pesticide residual & contaminated water is **decontaminated** with the help of biotechnology.

- 4) Enzymes like esterase, phosphatase, alkylsulphatase, oxygenase are used for **detoxification** of pesticides.

- 5) Organisms like Pseudomonas, Candida tropicalis, Aspergillus niger can degrade **herbicides** of chlorobenzoate class.

FOOD AND ALLIED INDUSTRY

- Waste from this industry have high **BOD** & **COD** value.

- Effluents from this industry have rich in **Carbohydrates.**

- With the help of **biomethanisation** reactor waste can convert into degradable form.

- Solid waste is a problem in fruit, vegetable,
  meat industry but now a days with the help
  of biotechnology this is suitable for **ethanol production** or **biomass.**

THE END