WELCOME

UNIT-5

BIOTECHNOLOGY

Dr.S.Anand Giri

H.O.D. Chemistry

OPJIT, Raigarh, C.G.


Absolute
©2004

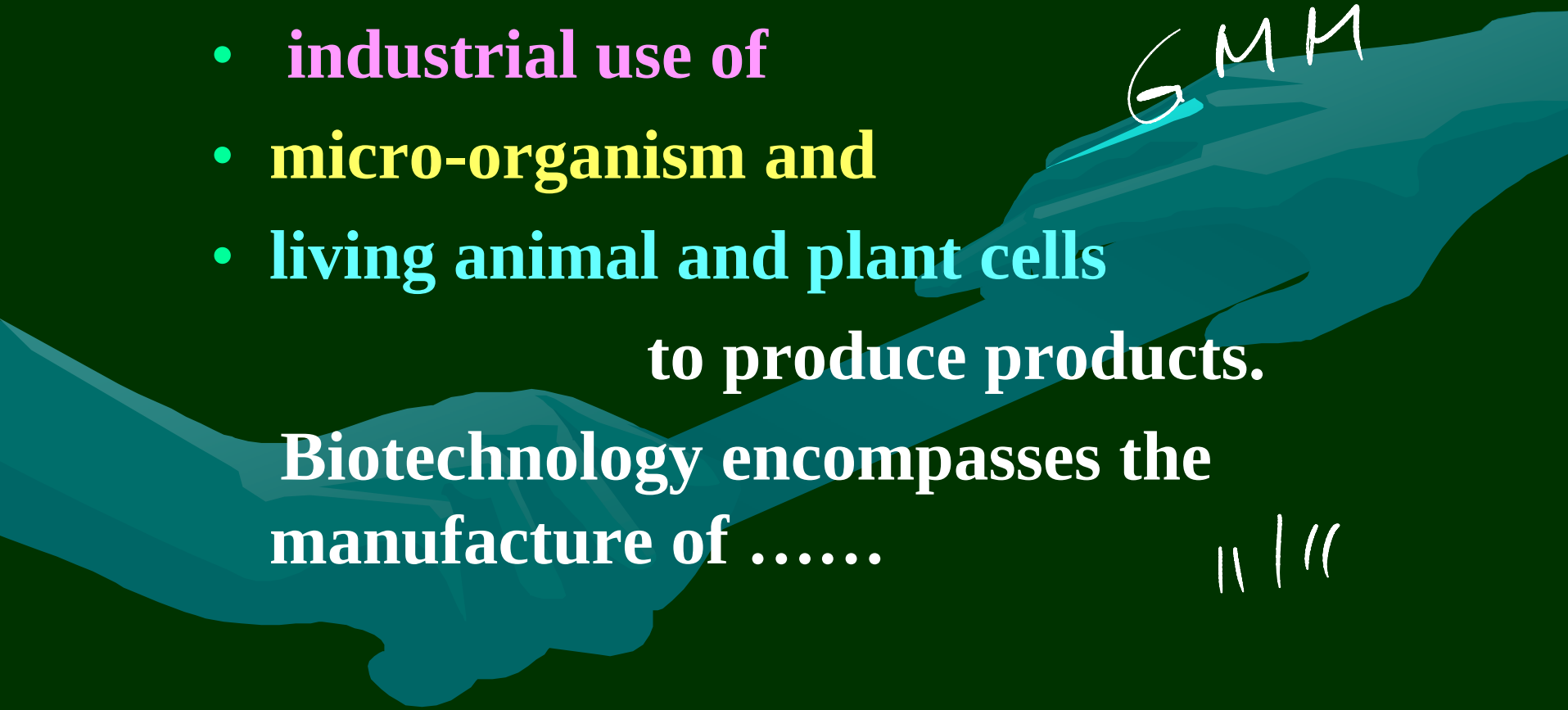
L- 45 Definition of Biotechnology

Introduction

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

to produce products.

Biotechnology encompasses the manufacture of ……

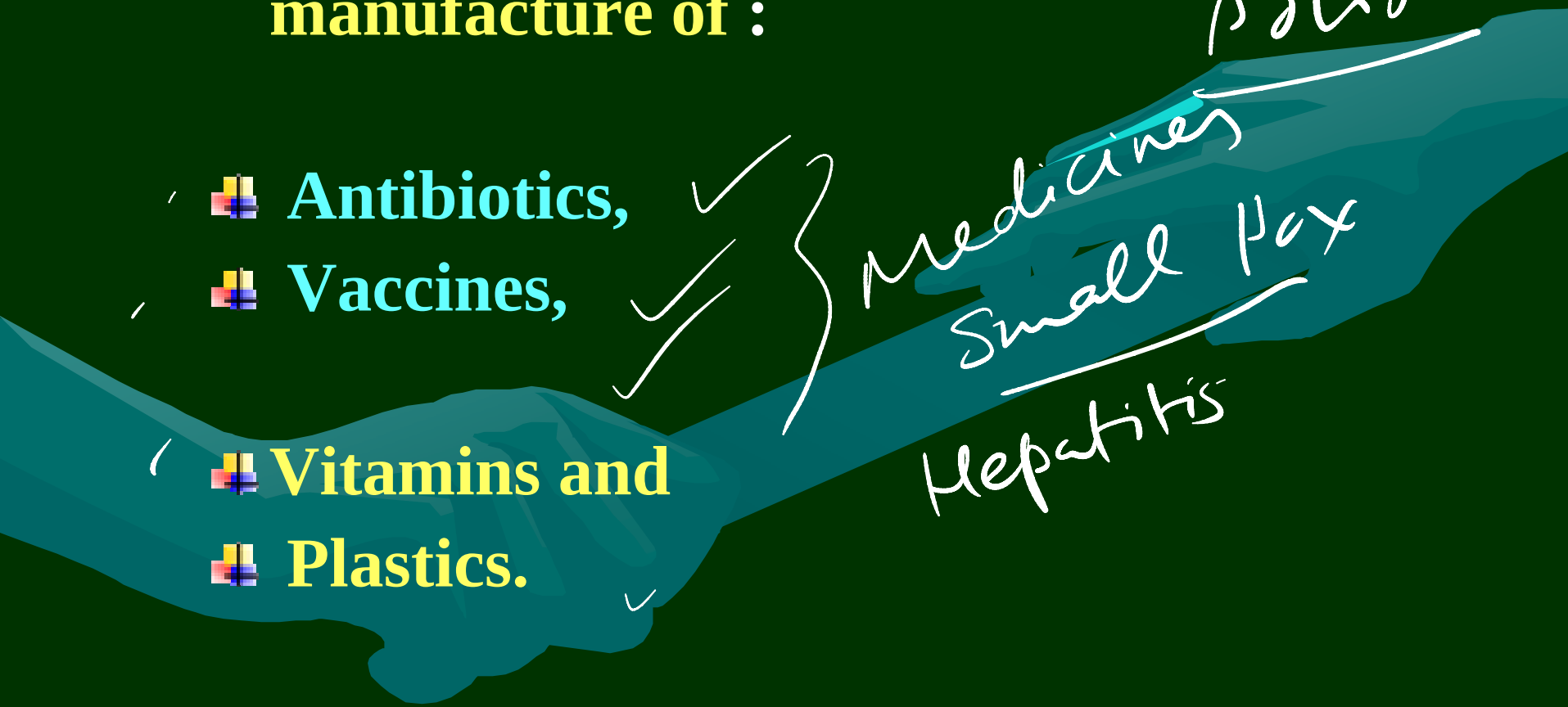


L- 45 Definition of Biotechnology

Introduction

Biotechnology encompasses the manufacture of :

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

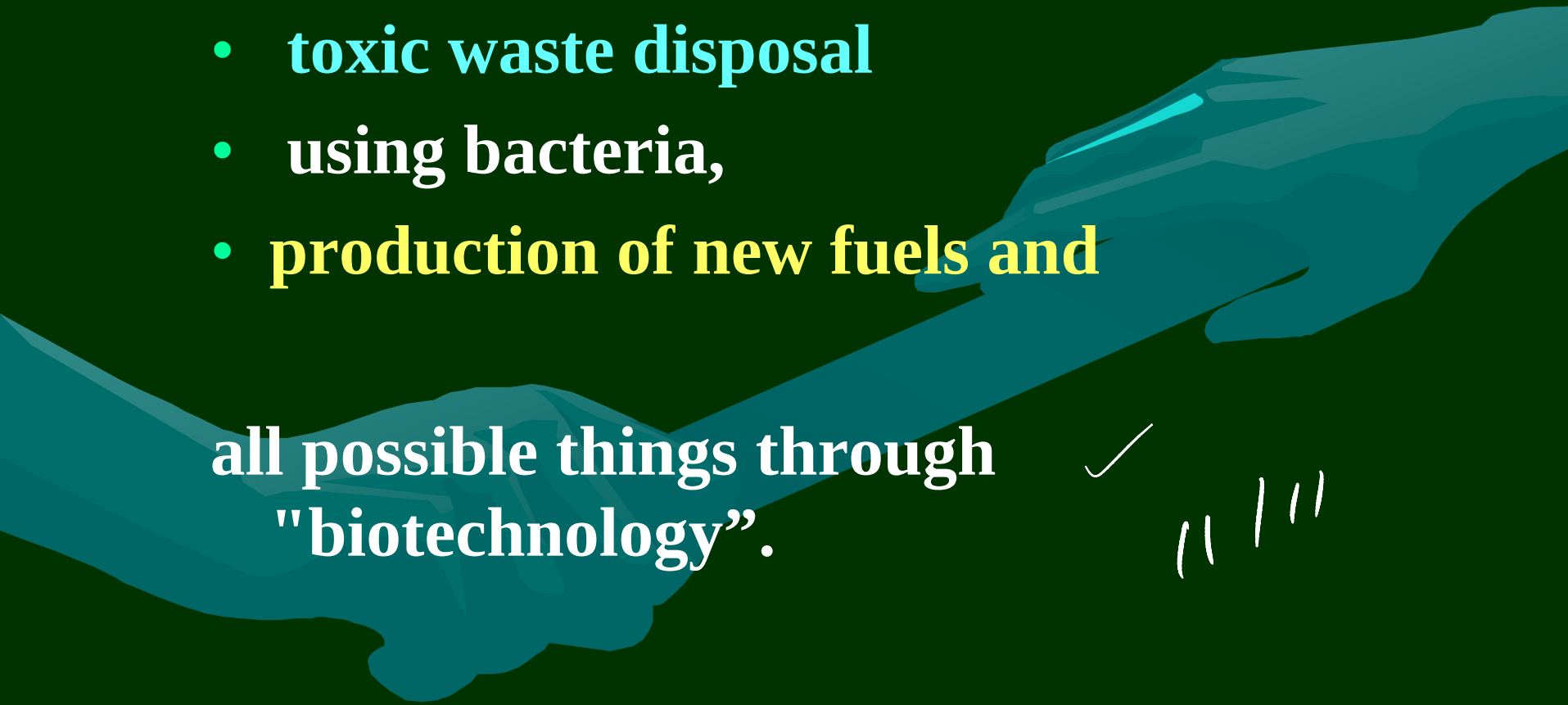


L- 45 Definition of Biotechnology

Introduction

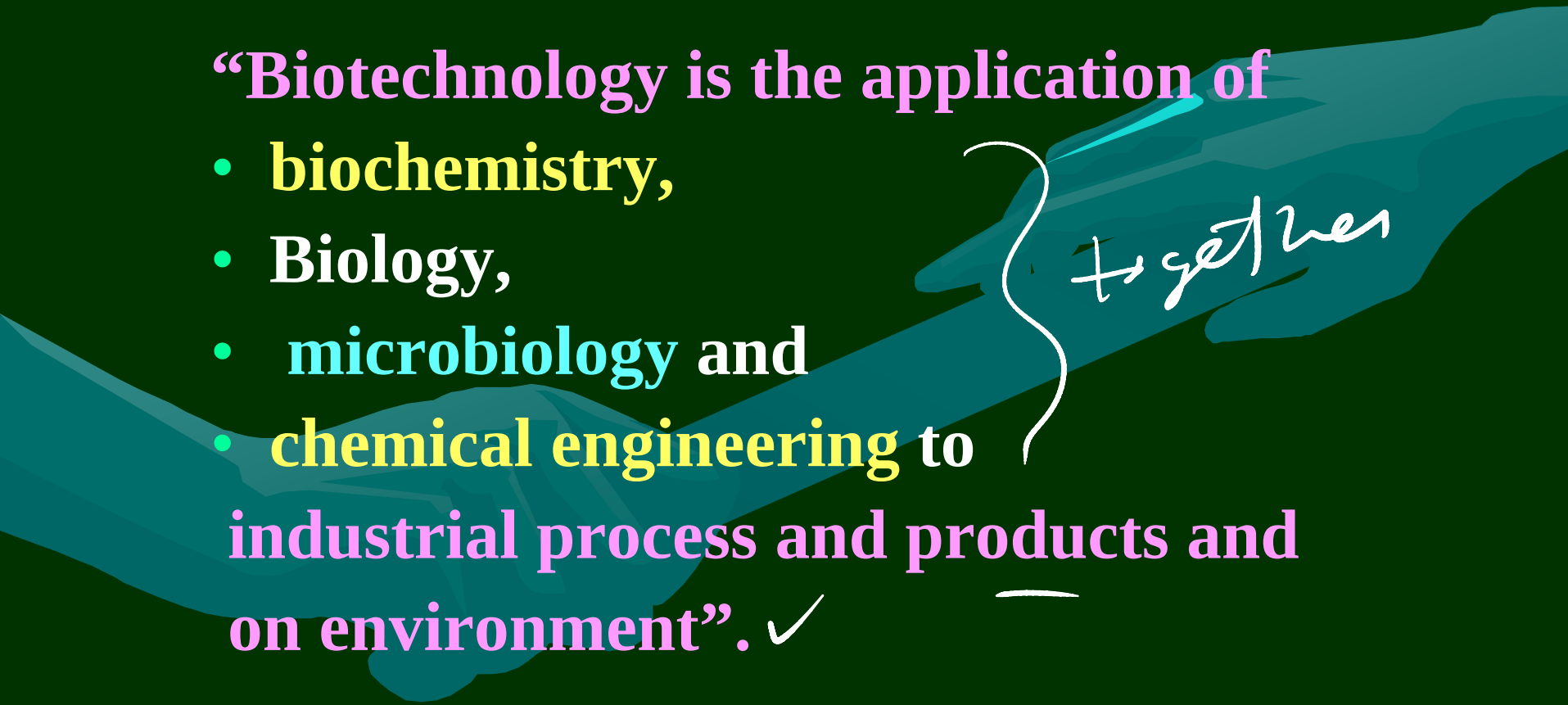
- Pollution control,
- toxic waste disposal
- using bacteria,
- production of new fuels and

all possible things through "biotechnology".



L- 45 Definition of Biotechnology

Biotechnology can be defined by number of ways:-



"Biotechnology is the application of

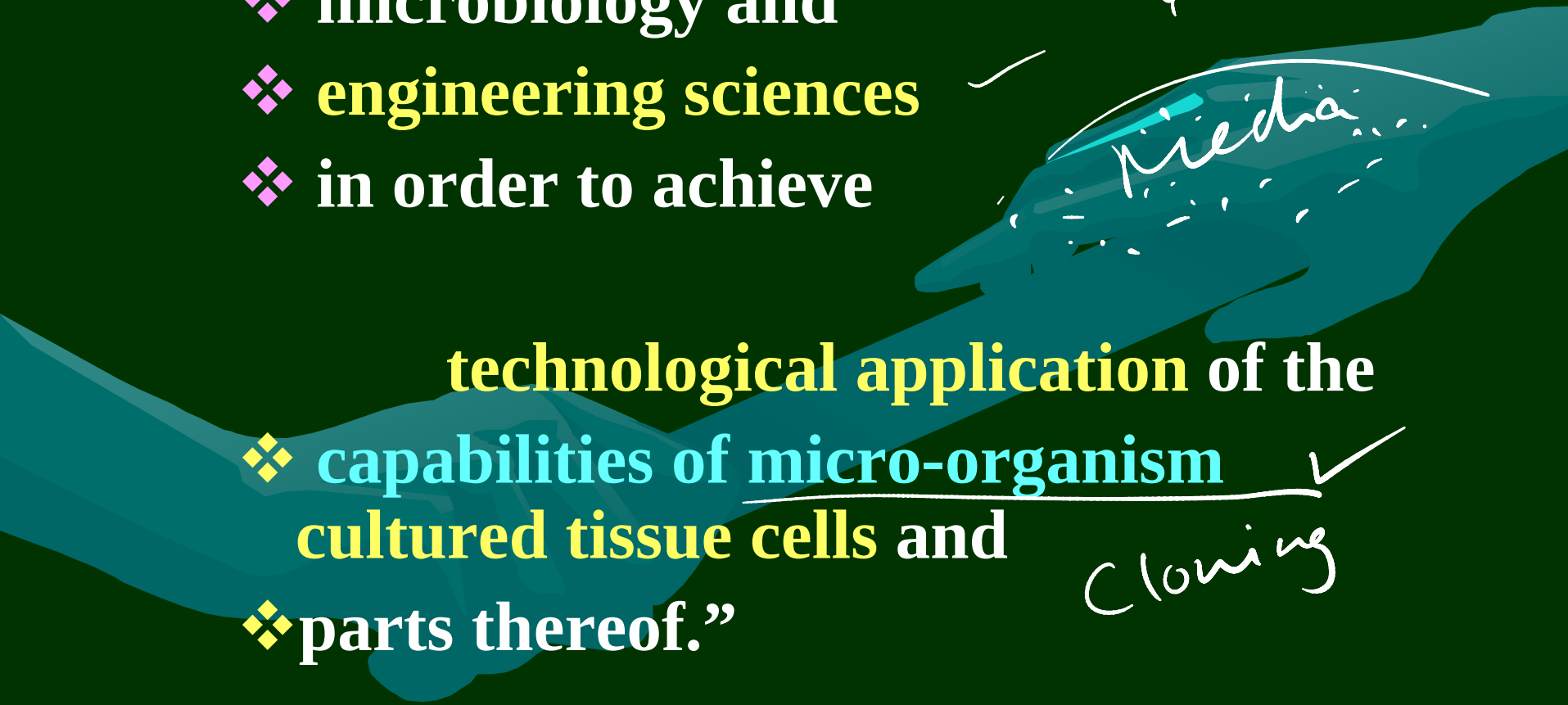
- **biochemistry,**
- **Biology,**
- **microbiology and**
- **chemical engineering to**

industrial process and products and on environment".

L- 45 Definition of Biotechnology

"Biotechnology is the integrated use of

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



technological application of the

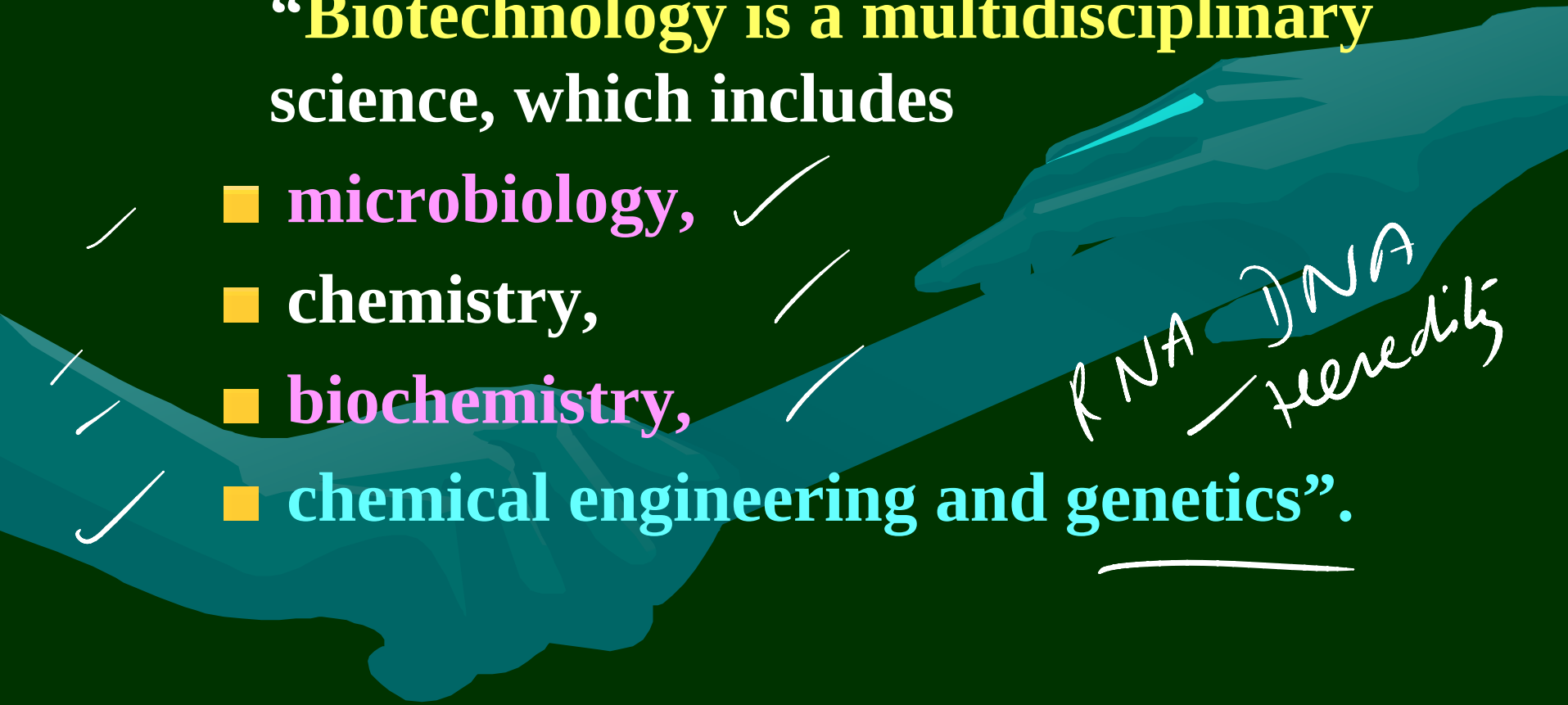
- capabilities of micro-organism cultured tissue cells and
- parts thereof."

L- 45 Definition of Biotechnology

So we can say

"Biotechnology is a multidisciplinary science, which includes

- microbiology,
- chemistry,
- biochemistry,
- chemical engineering and genetics".



L- 45 Definition of Biotechnology

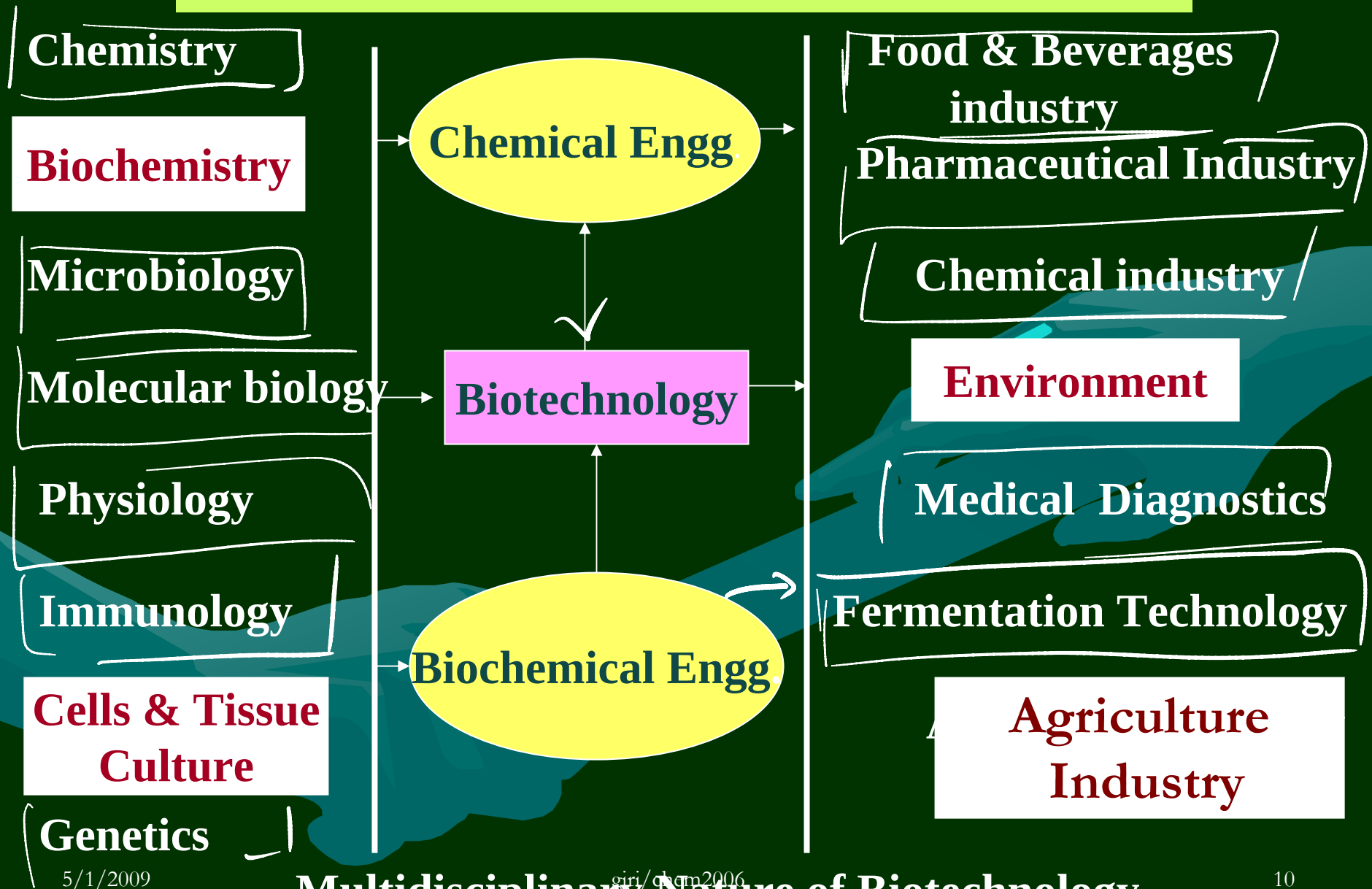
It has many application and significant contributions in different fields like

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

It has multidisciplinary nature.

Fig. shows its multidisciplinary nature.

L- 45 Definition of Biotechnology



Multidisciplinary Nature of Biotechnology

L-46 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.**

L-46 Current Status of Biotechnology in Environmental protection

- The current philosophy on this issue is that –
- 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 from waste may be used if possible.

L-46 Current Status of Biotechnology in Environmental protection

Use of biotechnology in industrial pollution control includes –

1. **Hazardous waste management.**
2. **Bioremediation of polluted land sites, and**
3. **Decontamination or detoxification of spillage.**

L-46 Current Status of Biotechnology in Environmental protection

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

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

L-46 Current Status of Biotechnology in Environmental protection

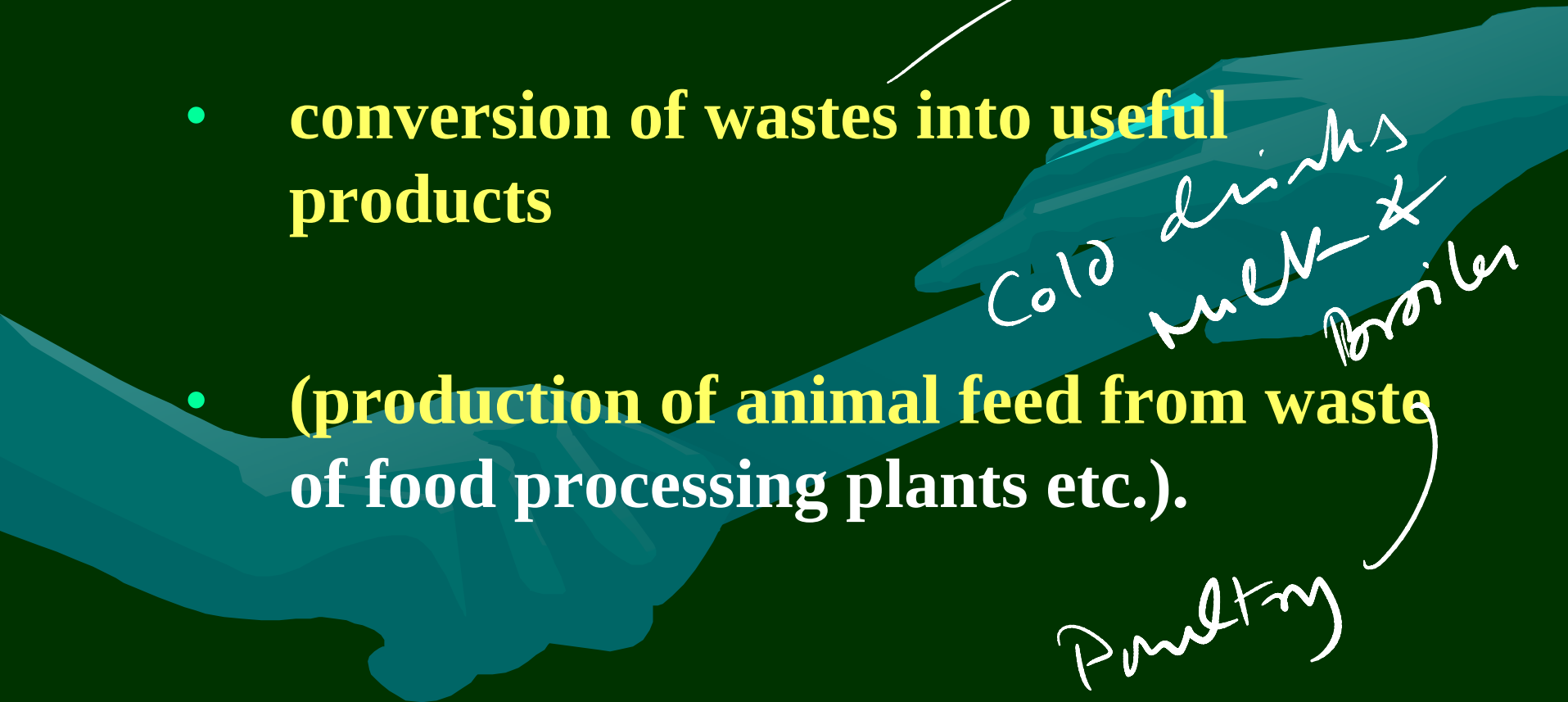
- **Single cell protein (SCP)**
- **Biomass/food/mushroom production from wastes.**

- **Modification of process or new processes /products**
- **to prevent pollution. (In tanning/paper/plastic industries).**

L-46 Current Status of Biotechnology in Environmental protection

(In tanning/paper/plastic industries).

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



L-46 Current Status of Biotechnology in Environmental protection

Effluent treatment for variety of industries.

- **Waste gas treatment and deodorization**
  - **i) removal of phenol,**
  - **ii) mercaptans,**
  - **iii) hydrocarbons,**
  - **iv) hydrogen sulfide.**

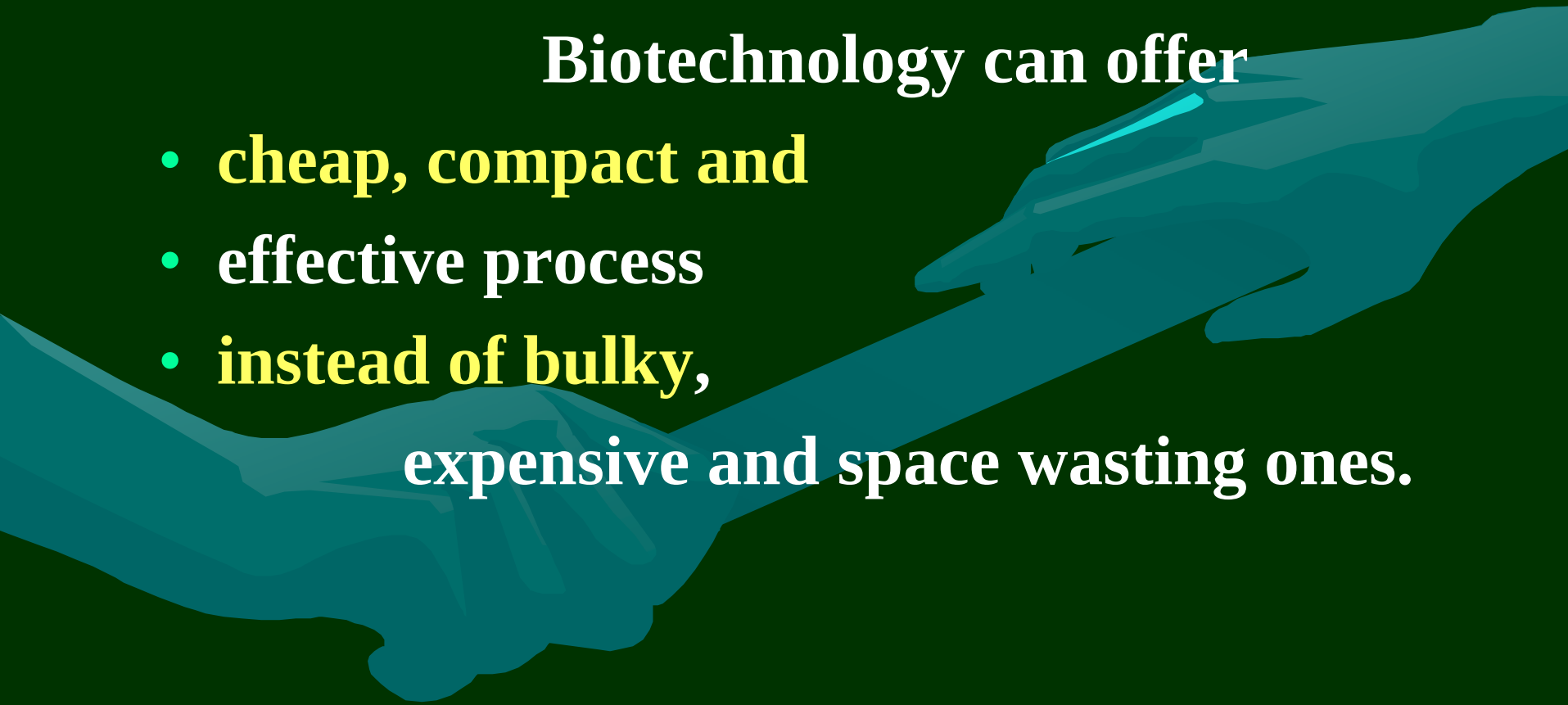
L-46 Current Status of Biotechnology in Environmental protection

Role of Biotechnology in Environmental Protection:

Biotechnology can offer

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

expensive and space wasting ones.



L-46 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.

L-46 Current Status of Biotechnology in Environmental protection

- Its full potential is not realized and
- laboratory and field successes has not been applied much.
- Important products, like ethanol can be obtained.

L-46 Current Status of Biotechnology in Environmental protection

Biotechnology can become effective if

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

issues are successfully tackled.

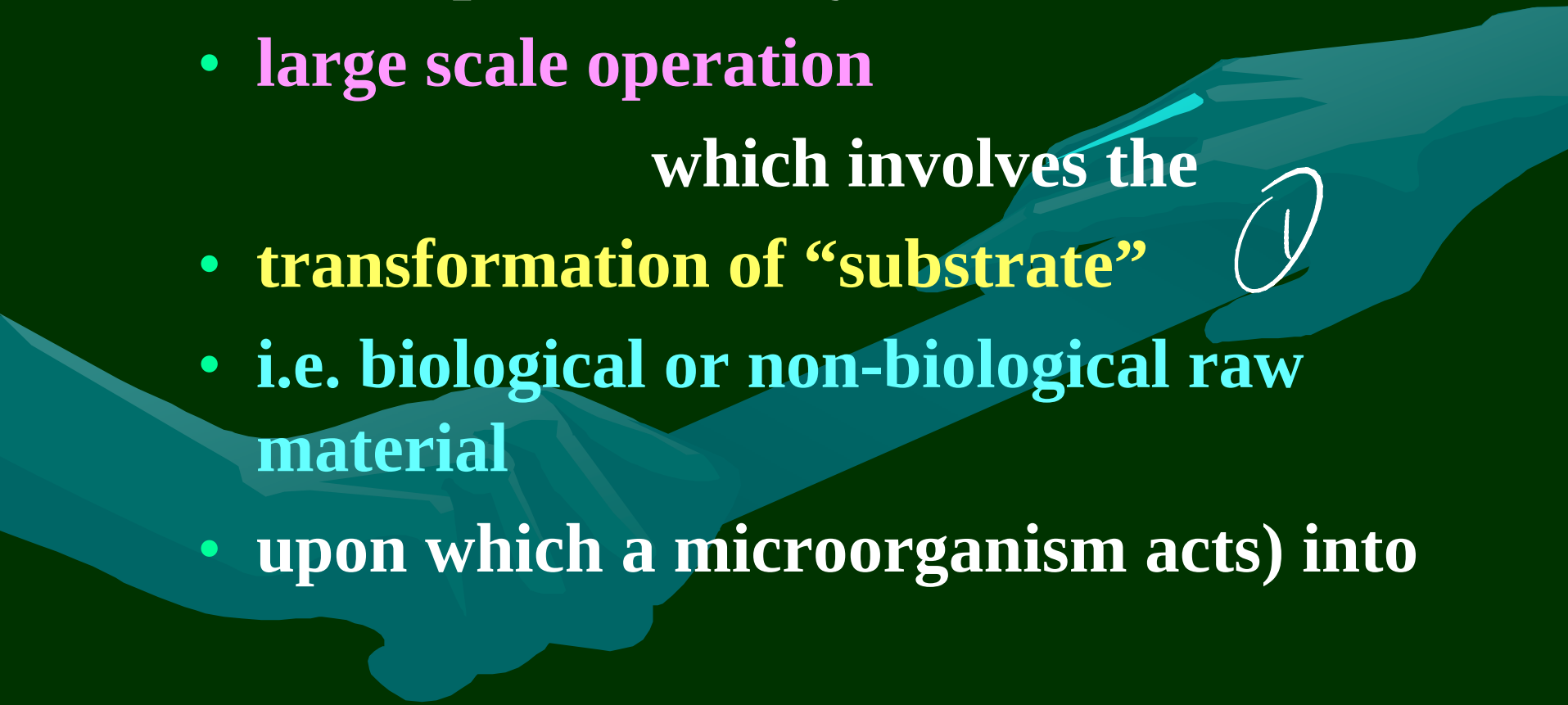

Absolute

L-46 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



L-46 Current Status of Biotechnology in Environmental protection

Biotechnological Process:

- some 'products'
- by means of micro-organism,

- animal or plant cell culture or
- by material (e.g. enzymes, organelles) derived from them.

L-46 Current Status of Biotechnology in Environmental protection

- Most biotechnological process can be represented as:

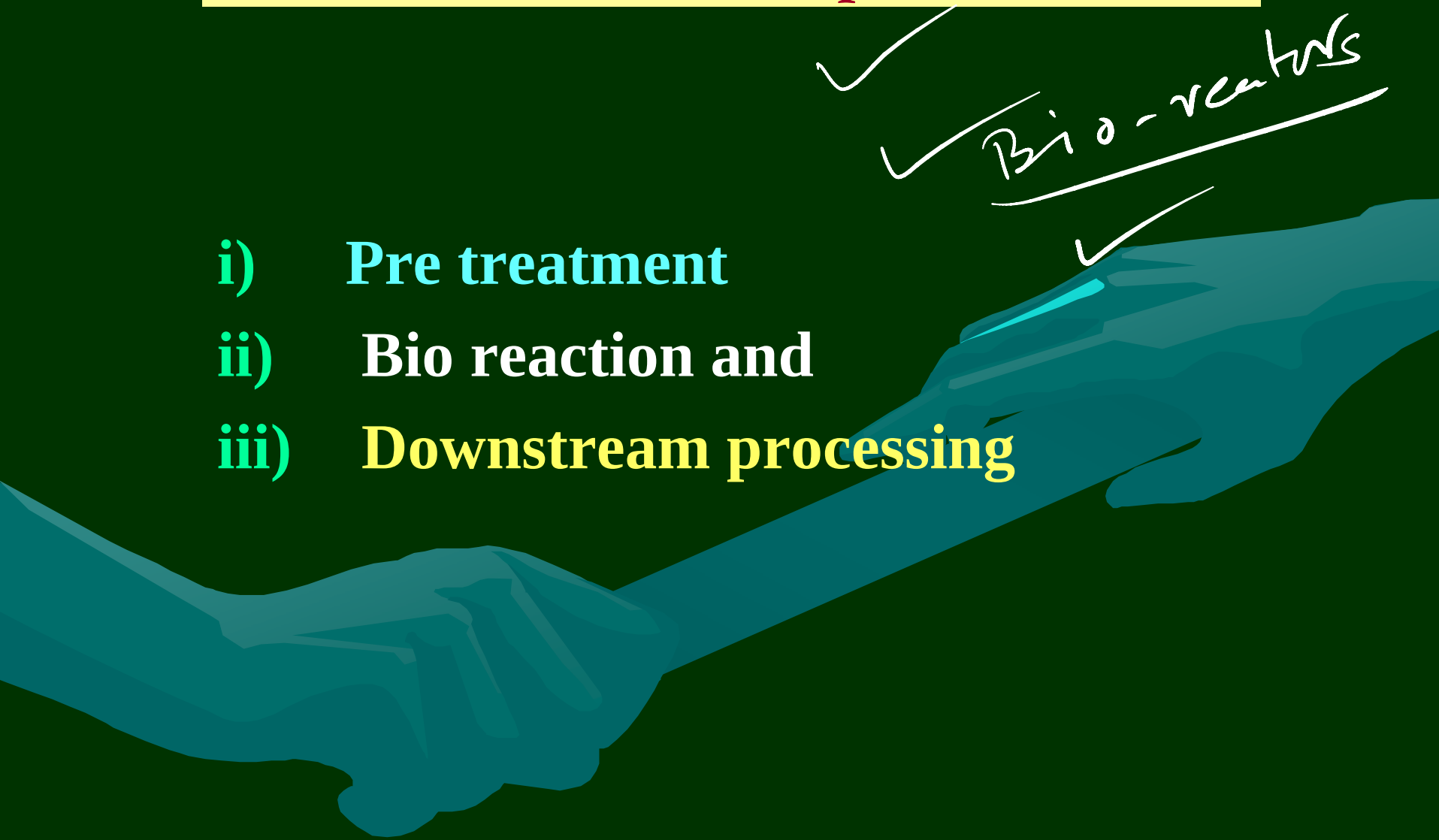
Process

Substrate +Micro – Organism ⟶ Products.

Engineering

There are three steps in any biotechnological process:-

L-46 Current Status of Biotechnology in Environmental protection



i) Pre treatment

ii) Bio reaction and

iii) Downstream processing

L-46 Current Status of Biotechnology in Environmental protection

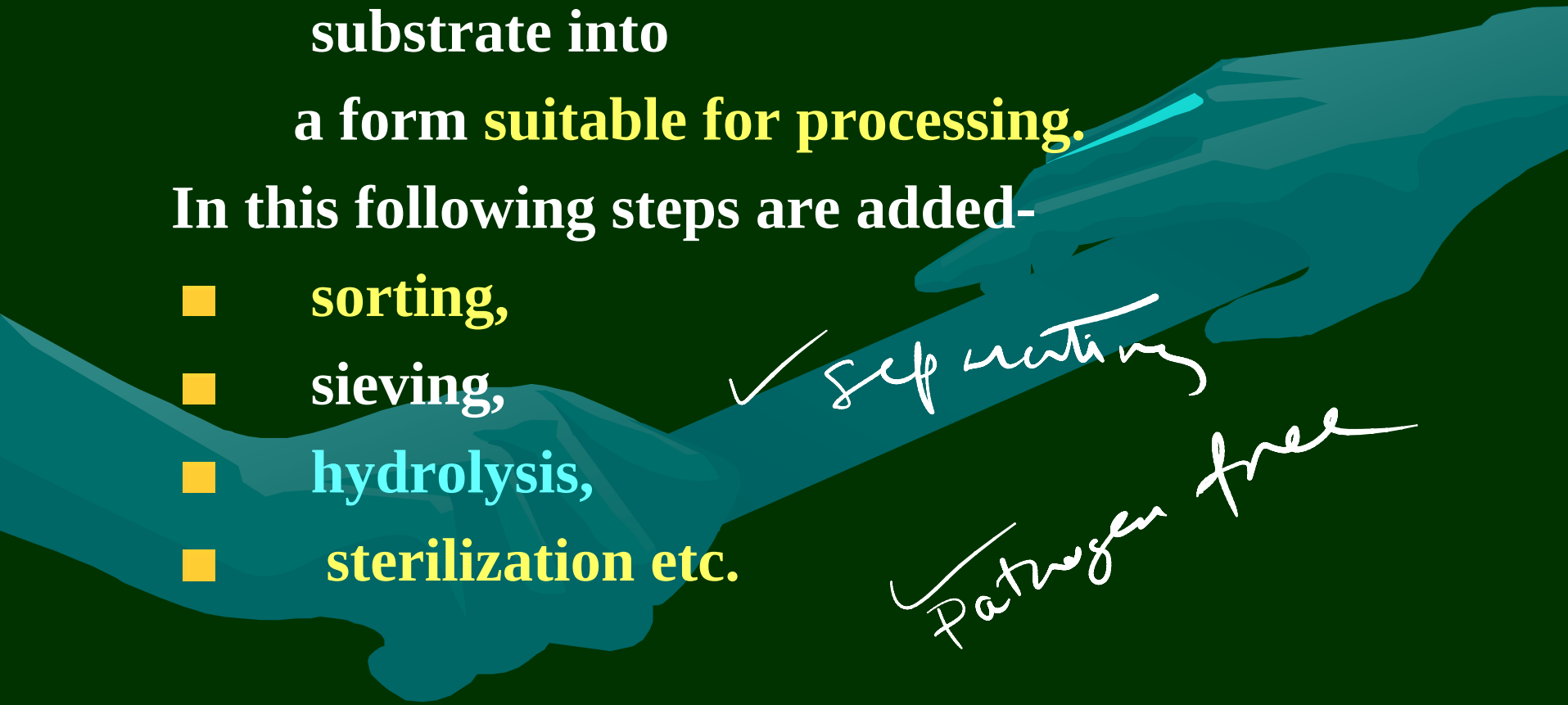
i) The Pre-Treatment Step:

Converts raw material or feed stock or substrate into

a form suitable for processing.

In this following steps are added-

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



L-46 Current Status of Biotechnology in Environmental protection

ii) Bio Reaction Step:
This is done in 'bioreactor'.

The operations are :

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

L-46 Current Status of Biotechnology in Environmental protection

iii) Downstream Processing:

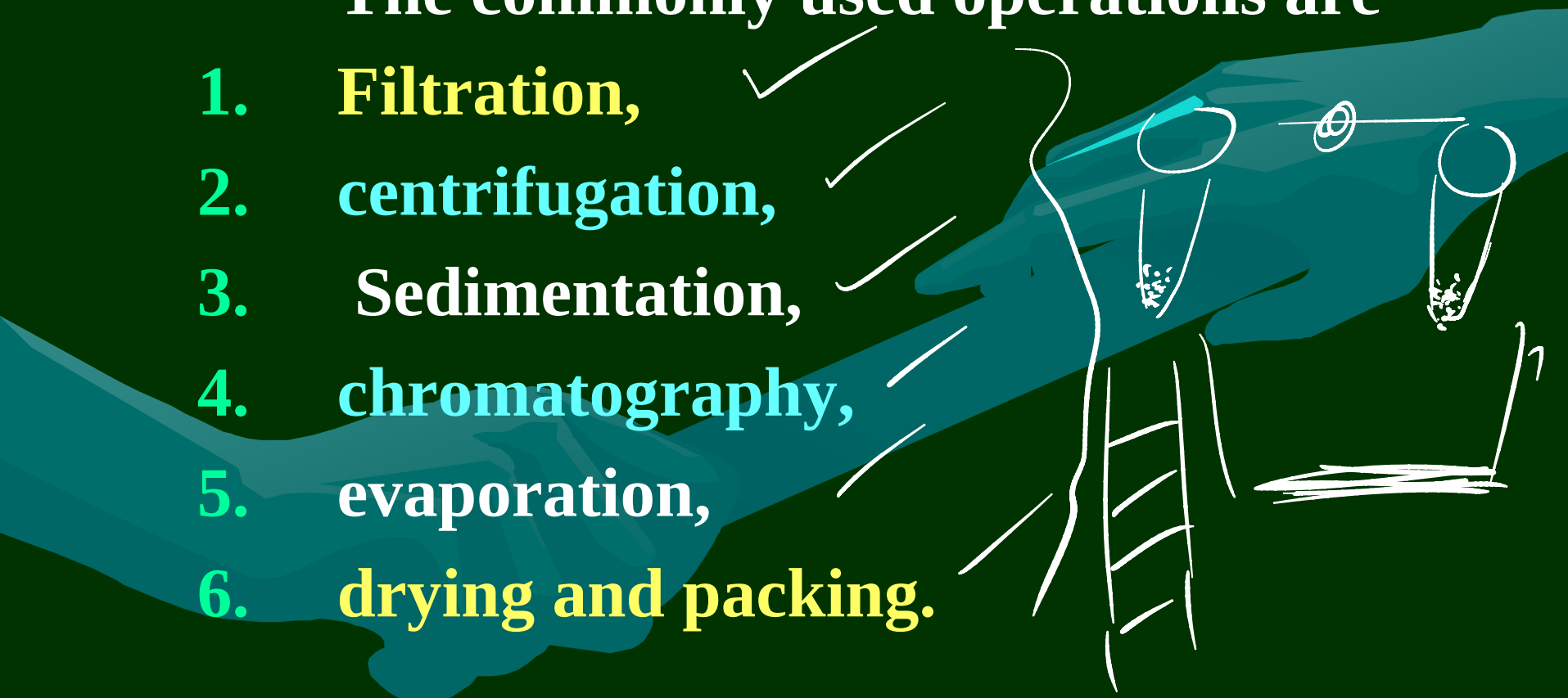
- The material produced is further processed in downstream section.
- The operations are –

L-46 Current Status of Biotechnology in Environmental protection

(Downstream Processing)

The commonly used operations are –

1. Filtration,
2. centrifugation,
3. Sedimentation,
4. chromatography,
5. evaporation,
6. drying and packing.



L-46 Current Status of Biotechnology in Environmental protection

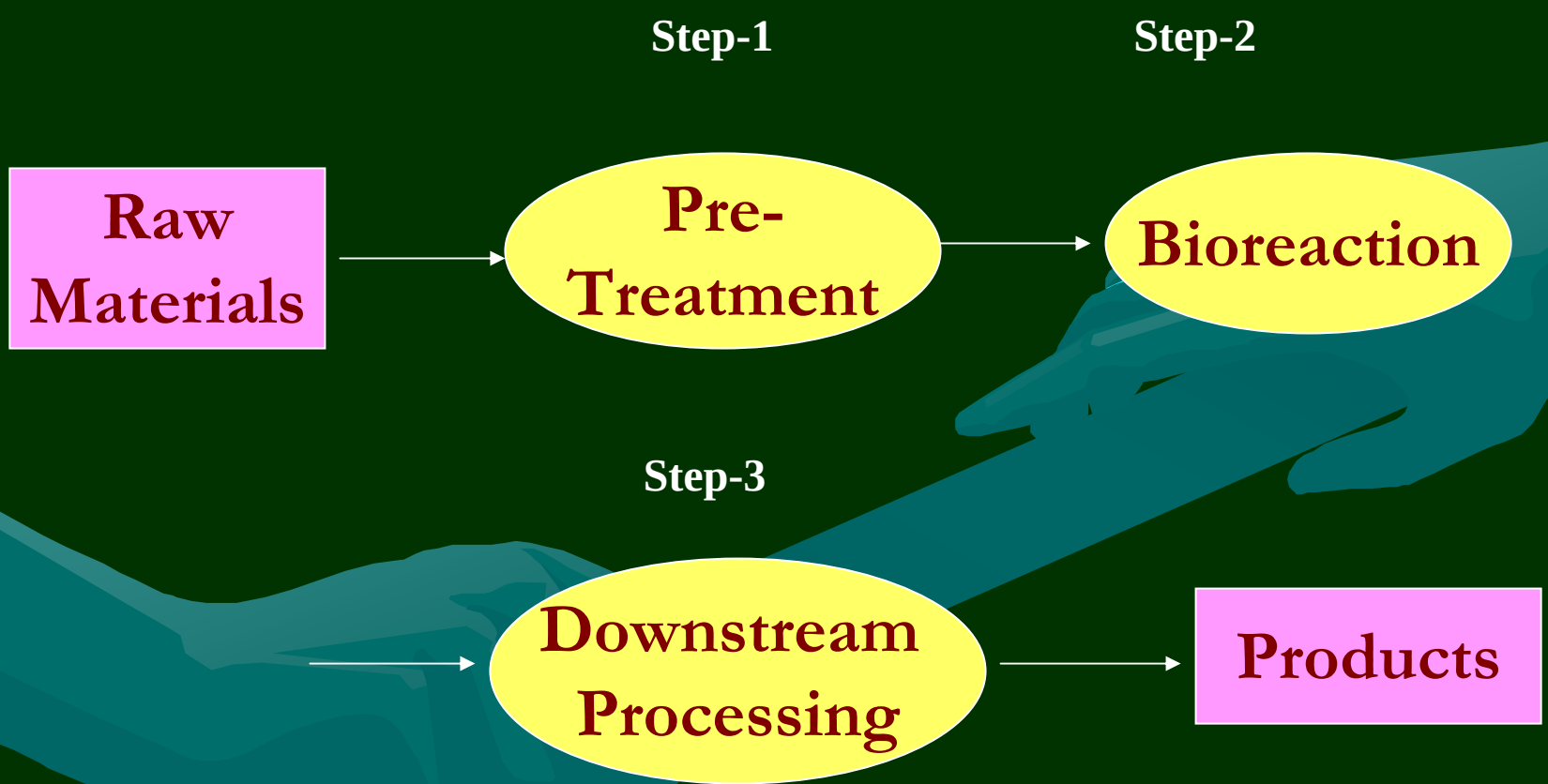
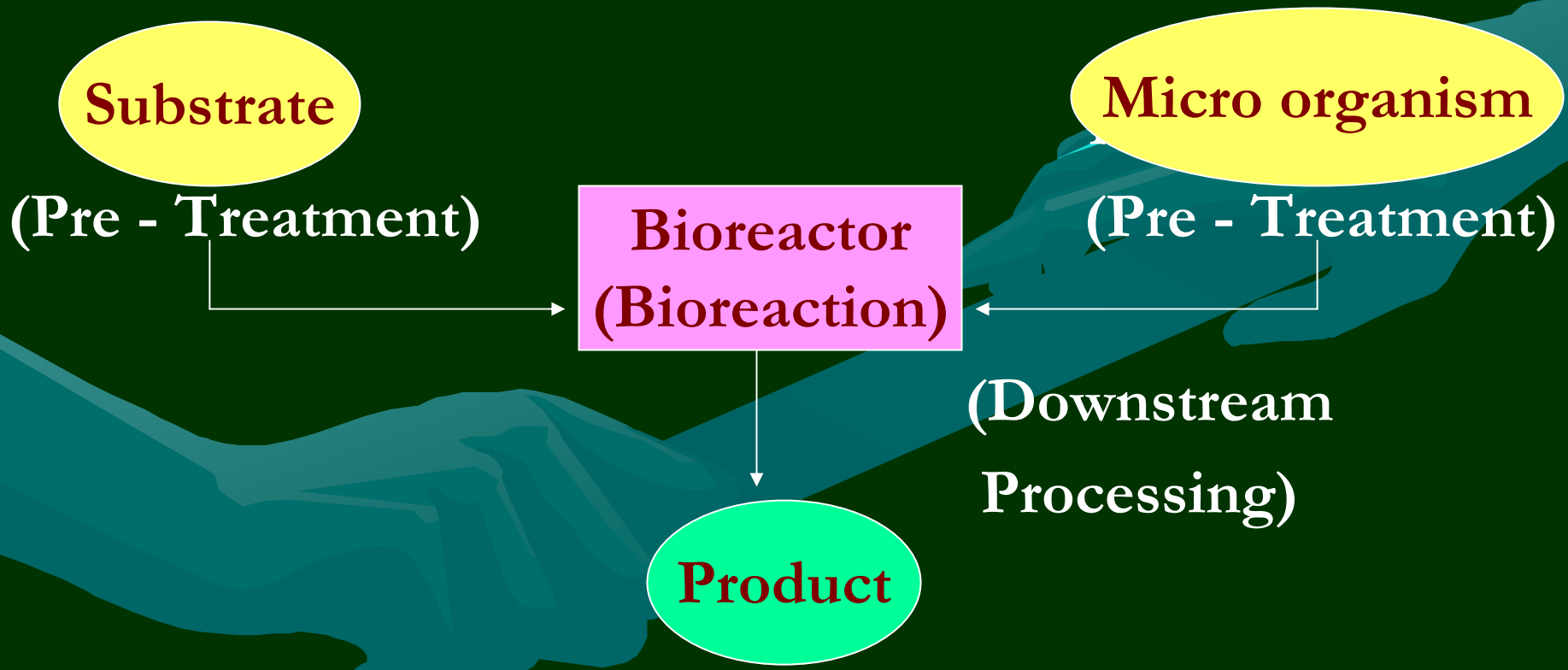


Fig.2 The Bioprocess Stages

L-46 Current Status of Biotechnology in Environmental protection

- A flow diagram presenting the biotechnological process is given below-




digitalblasphemy.com

L-47 Biofuels & Biofertilizers

BIO FUELS

- The bio fuels are biologically produced fuel.
- The diffused & inconvenient to use source of energy (biomass and sun light) are converted into
- dense and convenient to use fuels.

This process constitute the

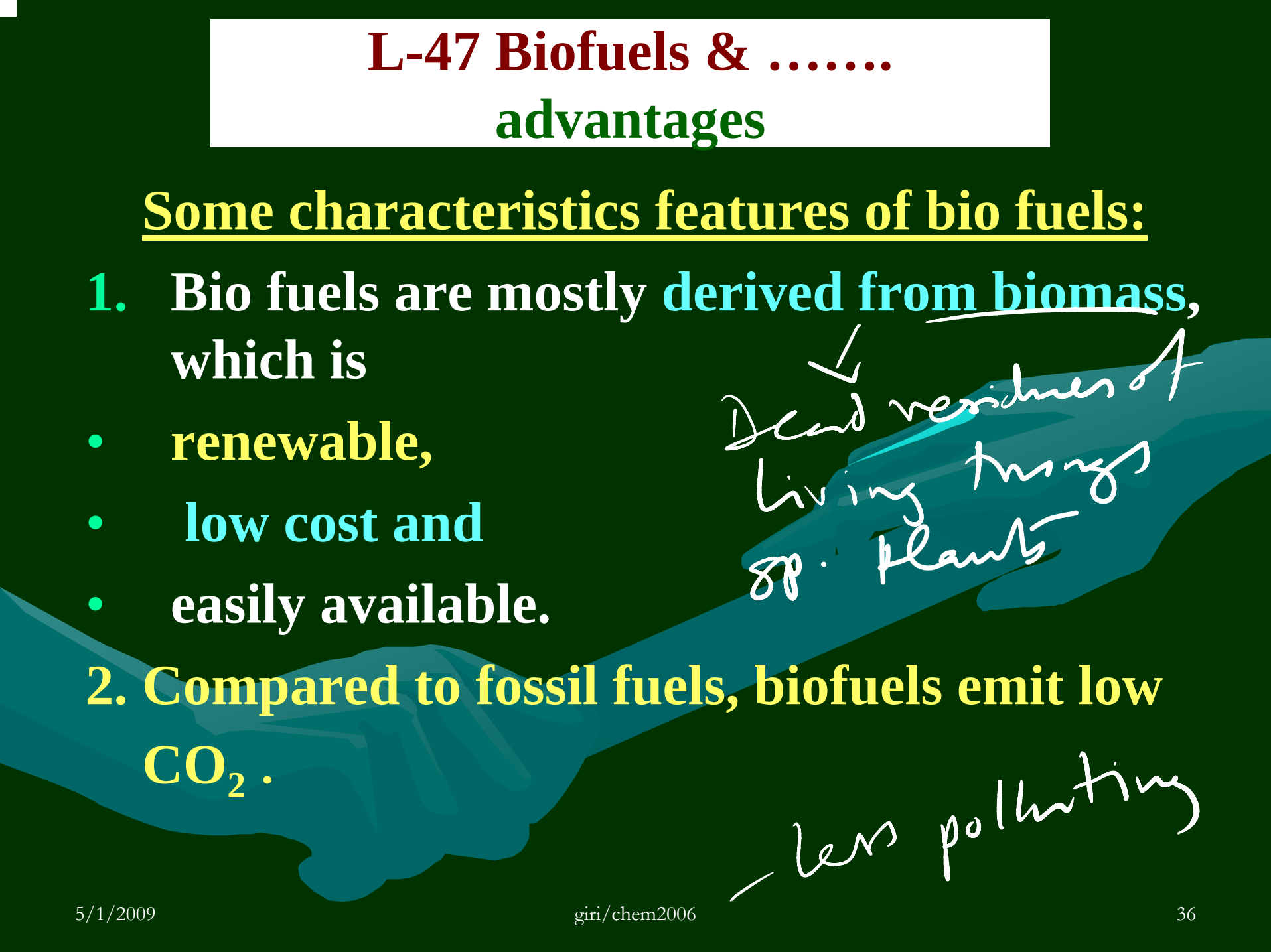
'fuel technology'.

13/11

L-47 Biofuels & ……. advantages

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 .



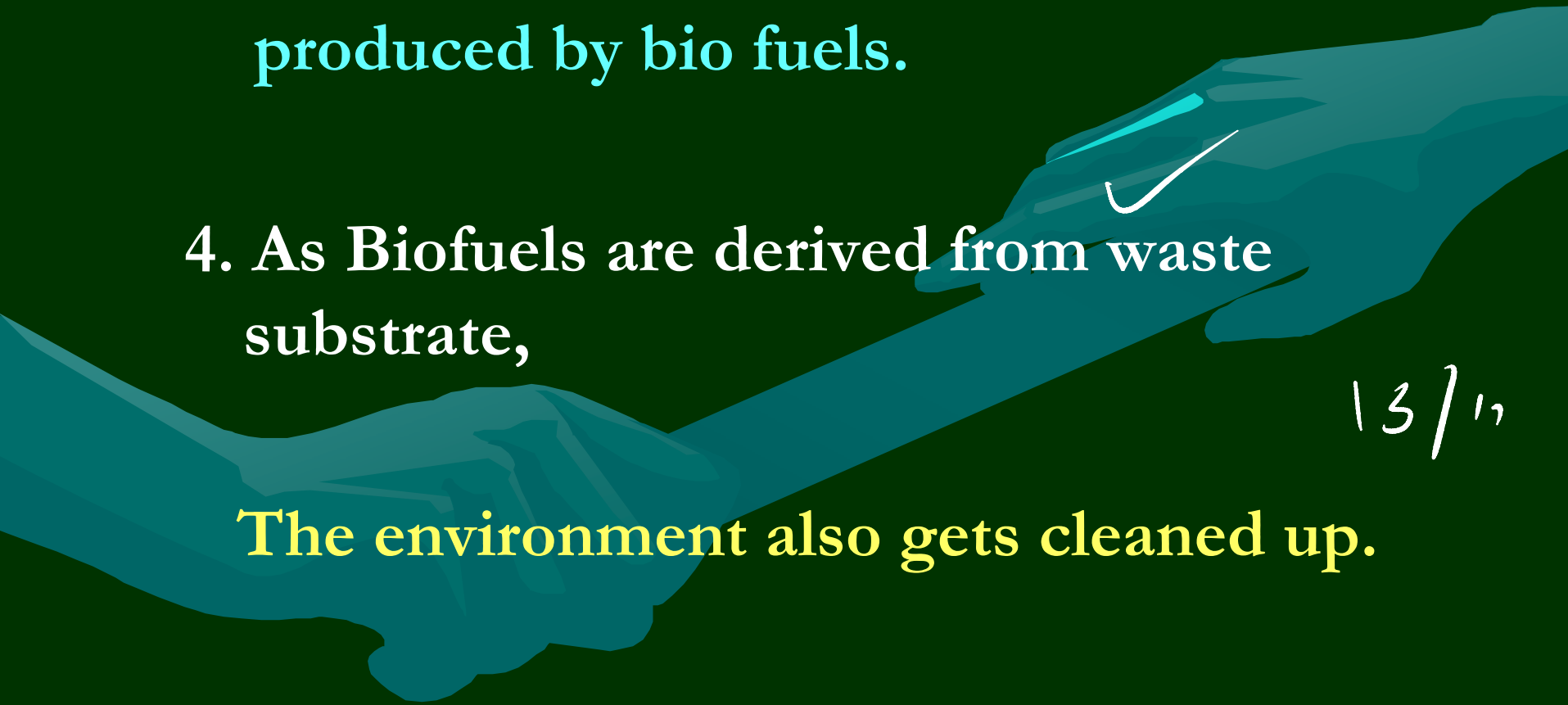
L-47 Biofuels & ……. advantages

Some characteristics features of bio fuels:

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

4. As Biofuels are derived from waste substrate,

The environment also gets cleaned up.



L-47 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 amount of substrate, this requires large area of land.
3. Low value of product and
4. Low profit margin.

L-47 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
- are used as a source of energy.

L-47 Biofuels & Biofertilizers

Sources of Biomass for fuel:

1. Land crops such as

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

2. Aquatic plants e.g.

- **water weeds and algae.**

3. Wastes like **domestic sewage,**

4. **wood and** crop residues e.g.

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

L-47 Biofuels & Biofertilizers

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

i) Biomass is renewable and it can be stored.

ii) Fuel has high energy content.

iii) It requires low investment.

iv) It does not increase the CO_2 in air

L-47 Biofuels & Biofertilizers

Energy Crops:-

Energy crops are those plants which

- use 'solar-energy' and
- convert CO_2 into the 'Biomass',

- Some plant species usable as fuel, are given below

L-47 Biofuels & Biofertilizers

Plant species	Nature of biomass	Mode of energy
1.Algae like chlamydomonas, anaerobic bacteria Like clostridium	Hydrogen	Biohydrogen
2.Crop residues, sewage, animal and human refuge.	Waste	Biogas
3.Algae, Euphorbia lathyris , Rapseed Jatropha	Hydrocarbons	Biodiesel
4.Sugarcane	Sugar	Bioethanol

L-47 Biofuels & Biofertilizers

Type of Biofuels:

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

$H_2O \rightarrow H_2\uparrow$

2. **Biogas** - is produced by the anaerobic degradation of organic matter.

Septic Tank
Composting

L-47 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.

L-47 Biofuels & Biofertilizers

3. Bio diesel –

- Is a diesel like liquid obtained from
- materials of biological origin like
- Oily seeds of and liquid accumulation in plants and algae
- or from hydrocarbons produced by some plants and algae.

L-47 Biofuels & Biofertilizers

4. Bio ethanol –

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

Jatropha and Rap seed oil

a substitute for Diesel -

L-47 Biofuels & Biofertilizers

4. Bio ethanol –

Jatropha and Rap seed oil as substitute for Diesel -

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

L-47 Biofuels & Biofertilizers

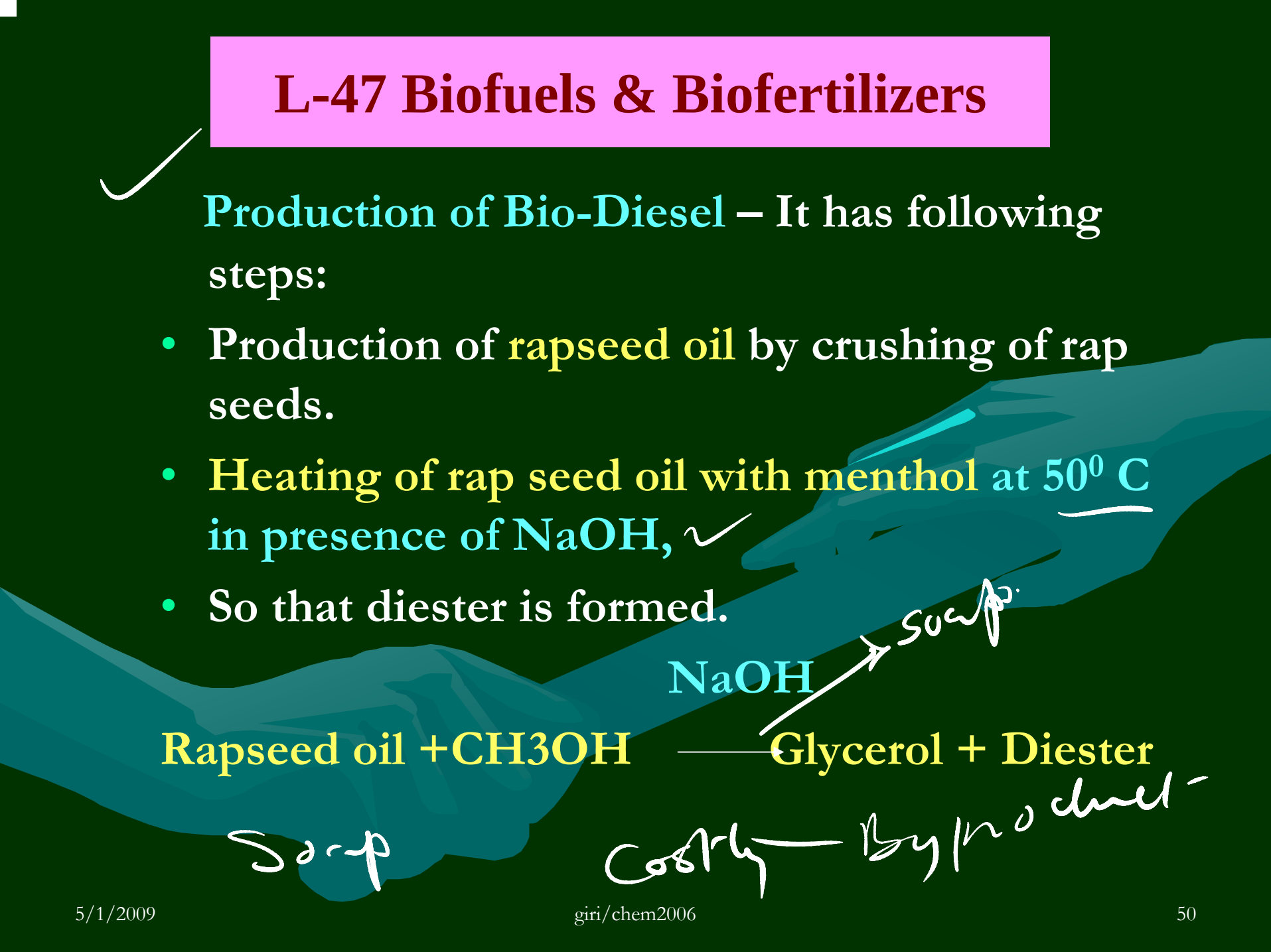
The advantages of biodiesel–

- I t is 98% bio degradable.
- It is non-toxic.
- The raw material is renewable.
- Energy yield is high.
- Its contribution to green house effect is less than that of diesel.

L-47 Biofuels & Biofertilizers

Production of Bio-Diesel – It has following steps:

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



Rapseed oil +CH3OH —NaOH→ Glycerol + Diester

L-47 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.

L-47 Biofuels & Biofertilizers

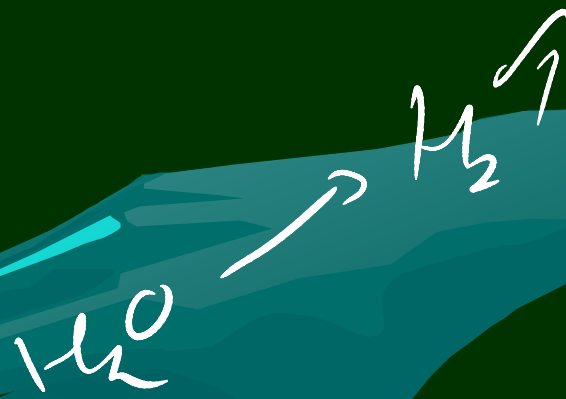
Advantages of using algae as a bio fuel are:-

- **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.**

L-47 Biofuels & Biofertilizers

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

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



- H_2 produced from water by a process "Biophotolysis".

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

L-47 Biofuels & Biofertilizers

Advantage of using hydrogen as a bio-fuel are

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

L-47 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 algae is direct and renewable source of solar energy.

L-47 Biofuels & Biofertilizers

6. Methane as a source of energy:-

- Methane is produced by
- 'Anaerobic degradation' or from
- proteins, carbohydrates and lipids.

L-47 Biofuels & Biofertilizers

8. 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.

L-47 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.

L-47 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.

L-47 Biofuels & Biofertilizers

BIO FERTILIZERS

- **Bio-fertilizers do 'Symbiosis' with plants means**
- **both get benefited from each other.**
- **Bio-fertilizers are**
- **environment friendly fertilizers.**

L-47 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.**

L-47 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.**

L-47 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.**

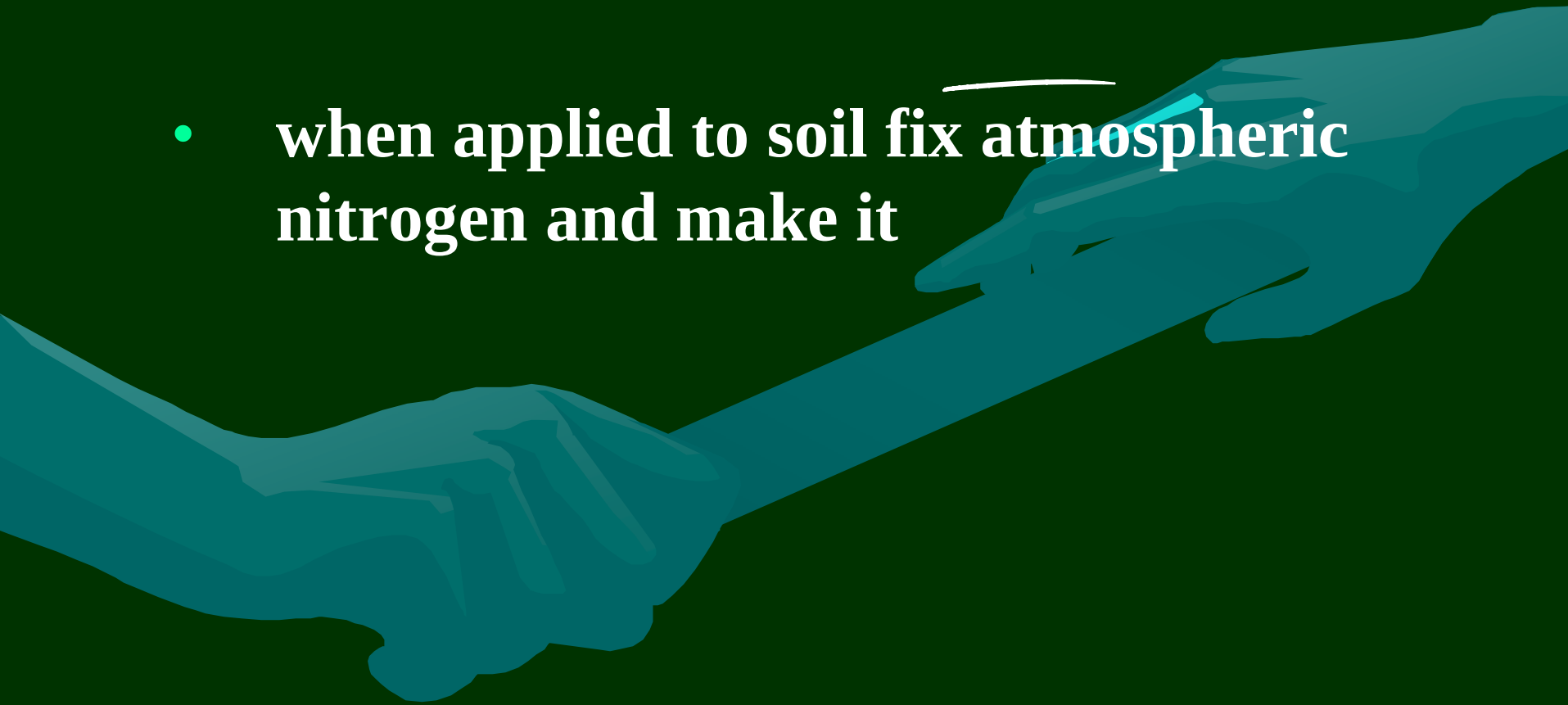
L-47 Biofuels & Biofertilizers

- 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.

L-47 Biofuels & Biofertilizers

2. A-symbiotic nitrogen fixers : ‘Azospirillum’ and ‘Azotobactor’,

- when applied to soil fix atmospheric nitrogen and make it



L-47 Biofuels & Biofertilizers

- available for Graminanceous crops like
- wheat, rice and sugarcane etc.
- They also synthesize growth promoting 'antibiotic substances' helpful for plants.

L-47 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

L-47 Biofuels & Biofertilizers

3) Algal fertilizers:

specialized structures called 'heterocysts'.

- These algae can accumulate biomass.
- They give growth promoting substance to soil.
- They provide partial tolerance to pesticides.

L-47 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.

13/11/06

L-47 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.

L-47 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 crops including pulses

L-47 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.**


Absolute

L-48 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.

L-48 Biosurfactants &…

The important functions of surfactants are –

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

- **surfactants are simple and complex lipids or lipid derivatives.**

L-48 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

L-48 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.

L-48 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.

L-48 Biosurfactants &…

The advantages of bio-surfactants are:

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

The disadvantages of Bio-surfactants:-

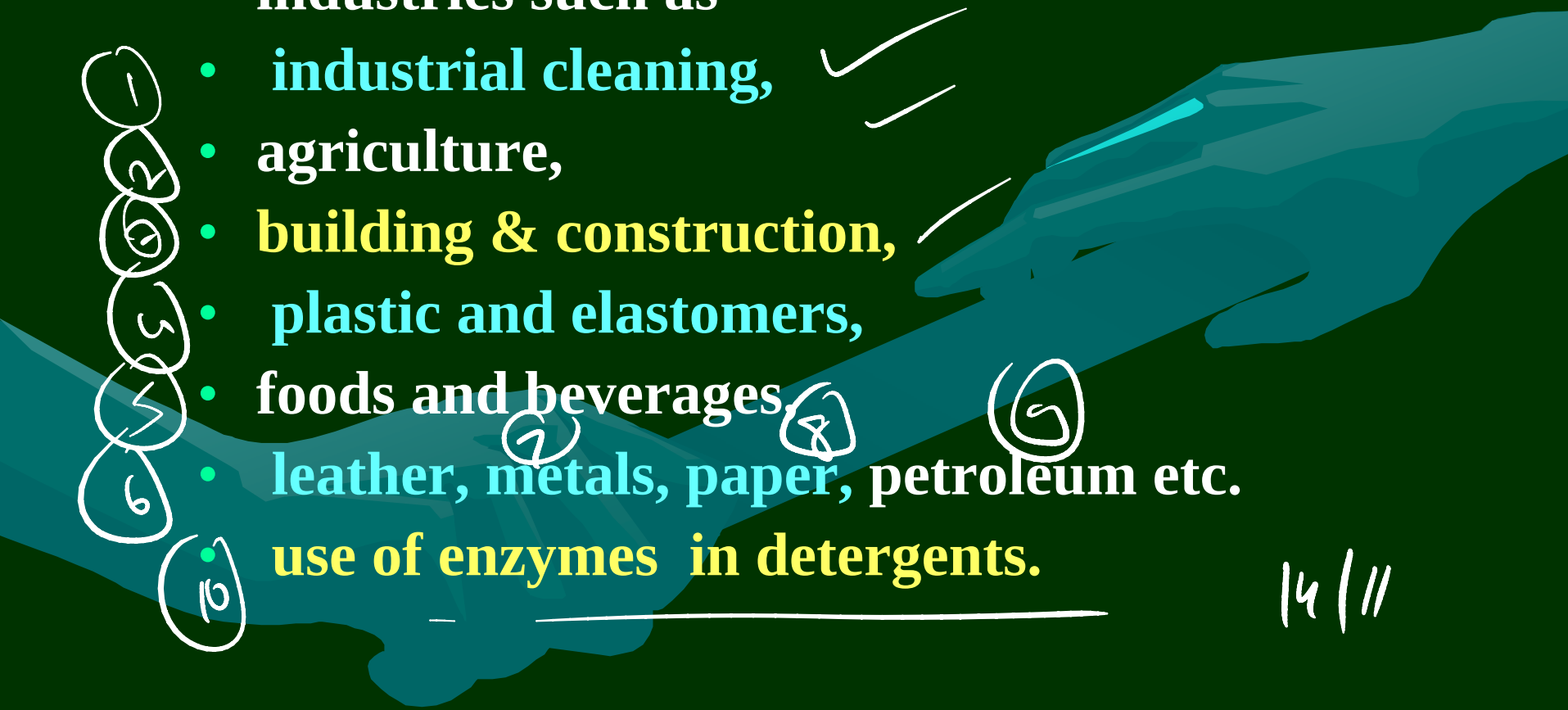
- **The recovery of bio-surfactants from the**
- **Fermentation and purification is**
- **difficult and costly.**

L-48 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.



L-48 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.**

L-48 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.

L-48 Biosurf.. & Biosensors

BIOSENSORS

Biosensors are combinations of

- biochemistry,
- membrane technology and
- microelectronics

which enable the signals produced by specific biochemical reactions to be

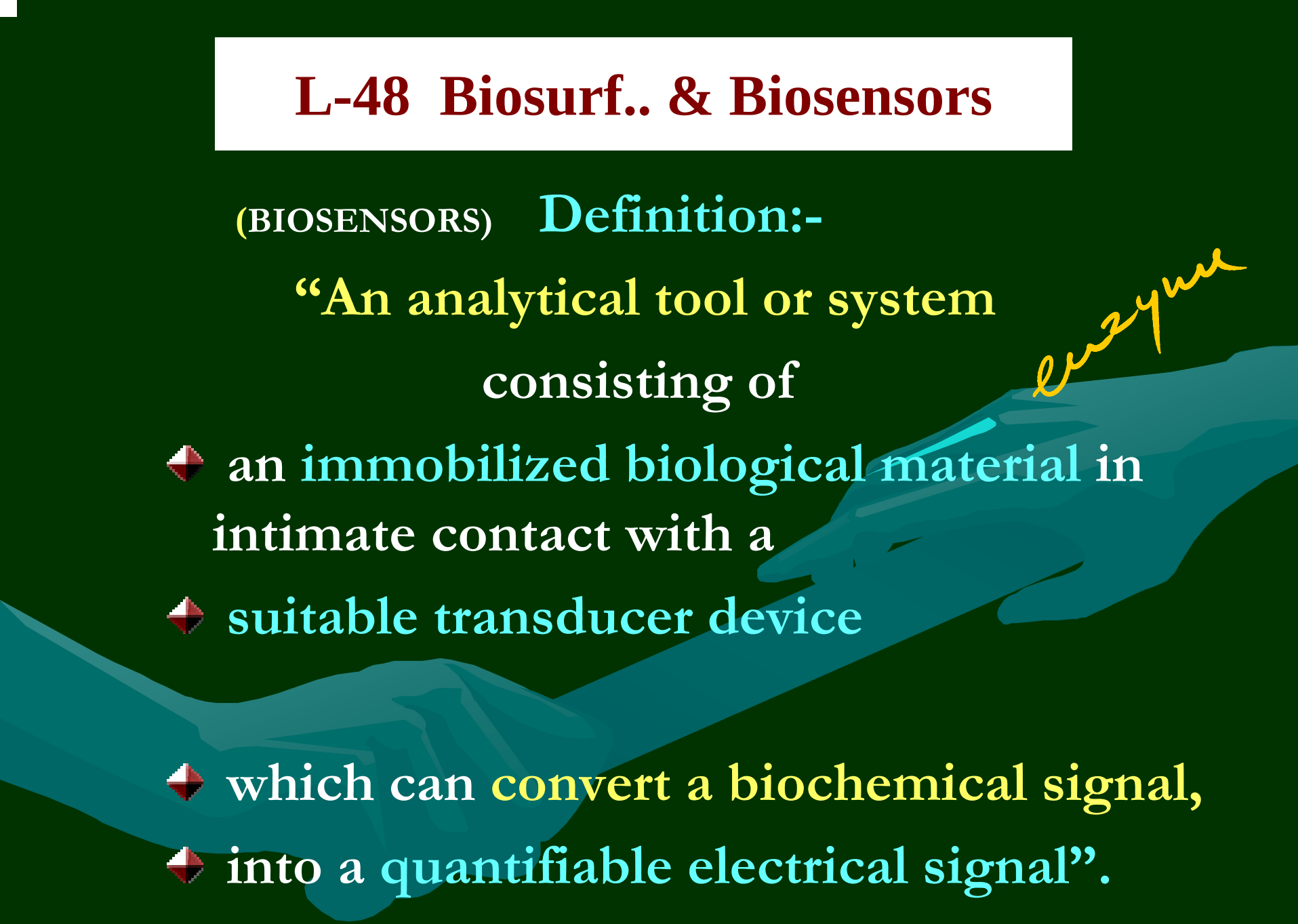
- registered,
- quantified and
- recorded.

L-48 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".

L-48 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.

L-48 Biosurf.. & Biosensors

(BIOSENSORS)

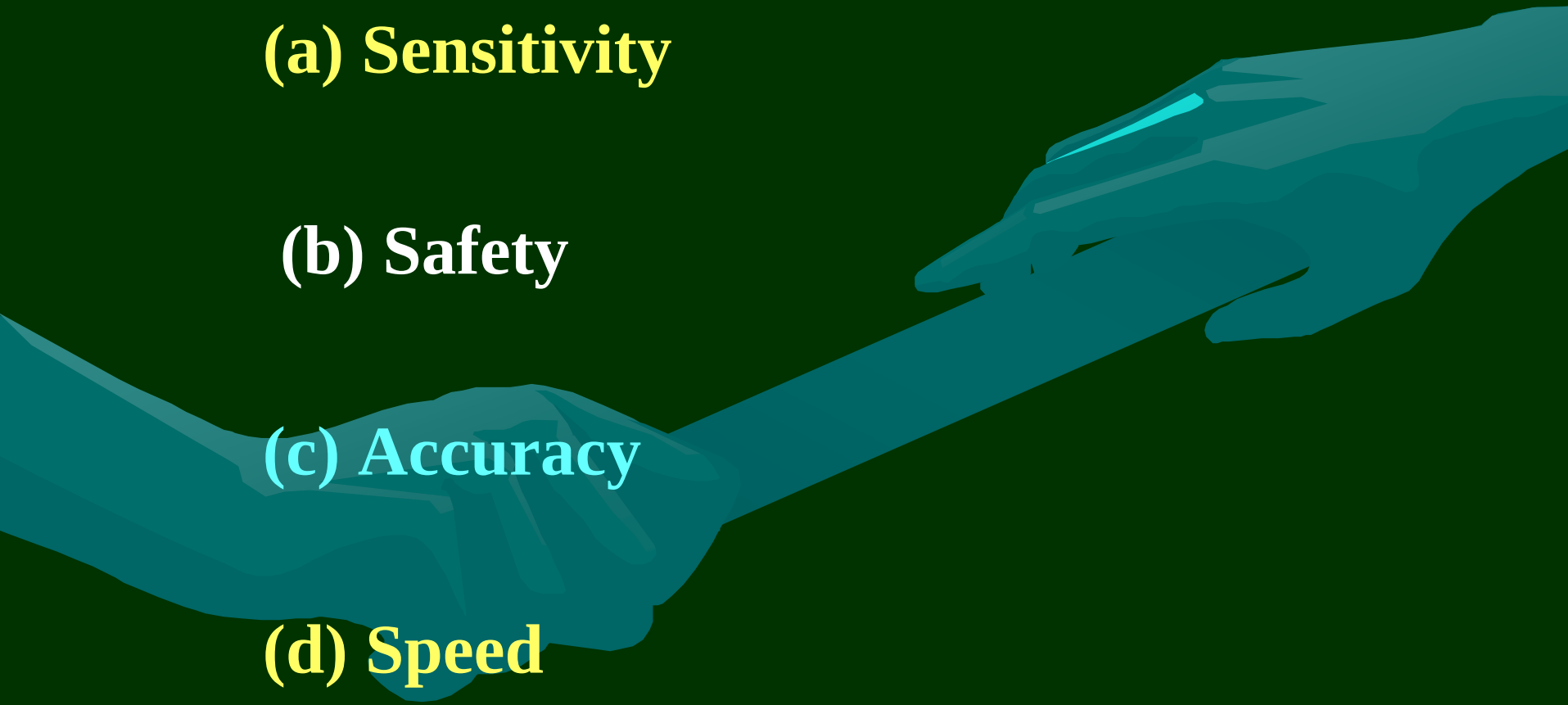
Characters of Biosensor

(a) Sensitivity

(b) Safety

(c) Accuracy

(d) Speed



L-48 Biosurf.. & Biosensors

(BIOSENSORS) Requirements of a Good Biosensor

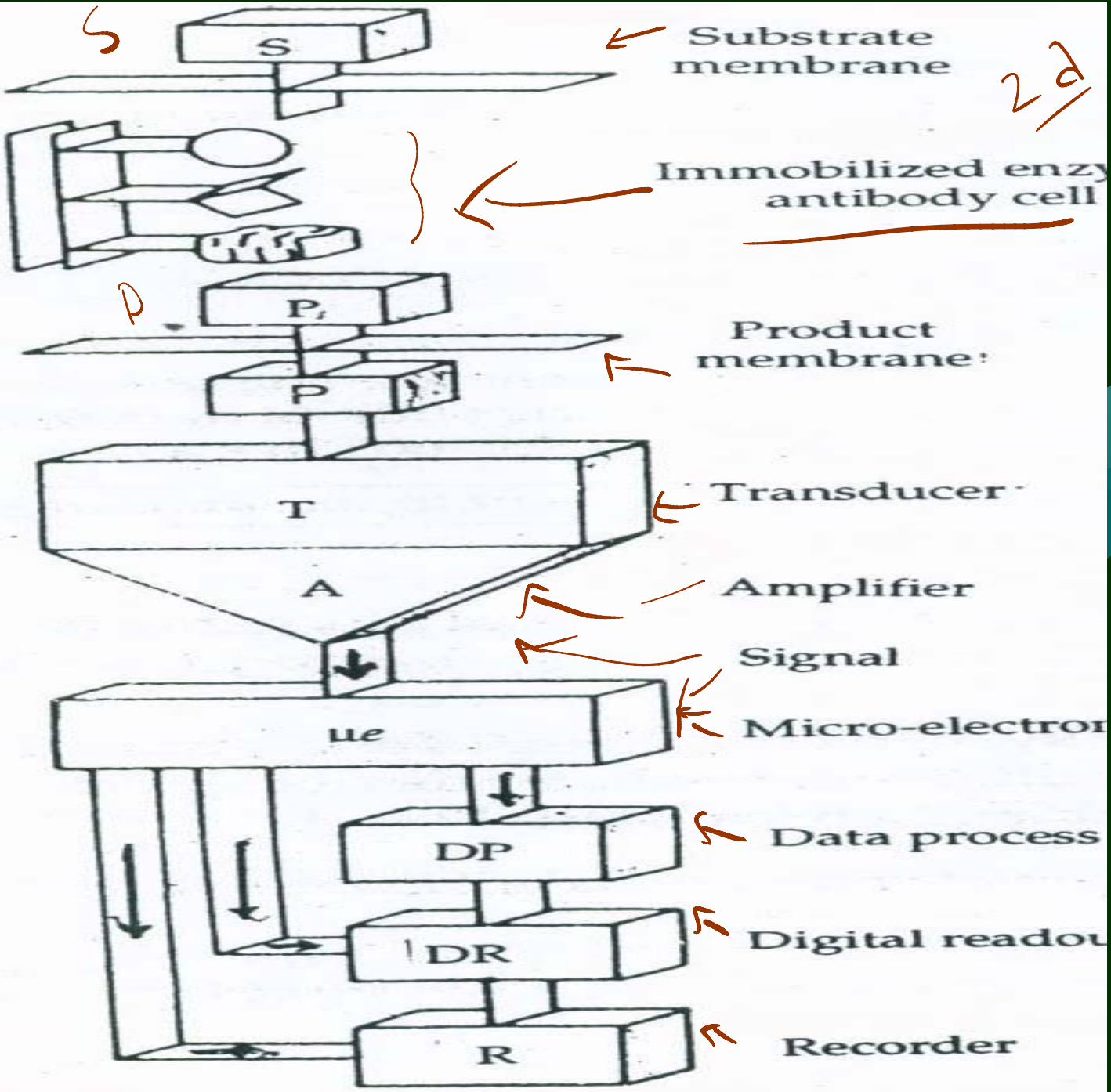
The device should be

1. cheap, small, easy to use and durable.

2. biocompatible and tiny.

   If it has to be used within the body,

3. highly specific for the analyte.


S
Substrate membrane
Immobilized enzy
antibody cell
P
Product membrane
T
Transducer
A
Amplifier
Signal
Micro-electron
DP
Data process
DR
Digital readou
R
Recorder

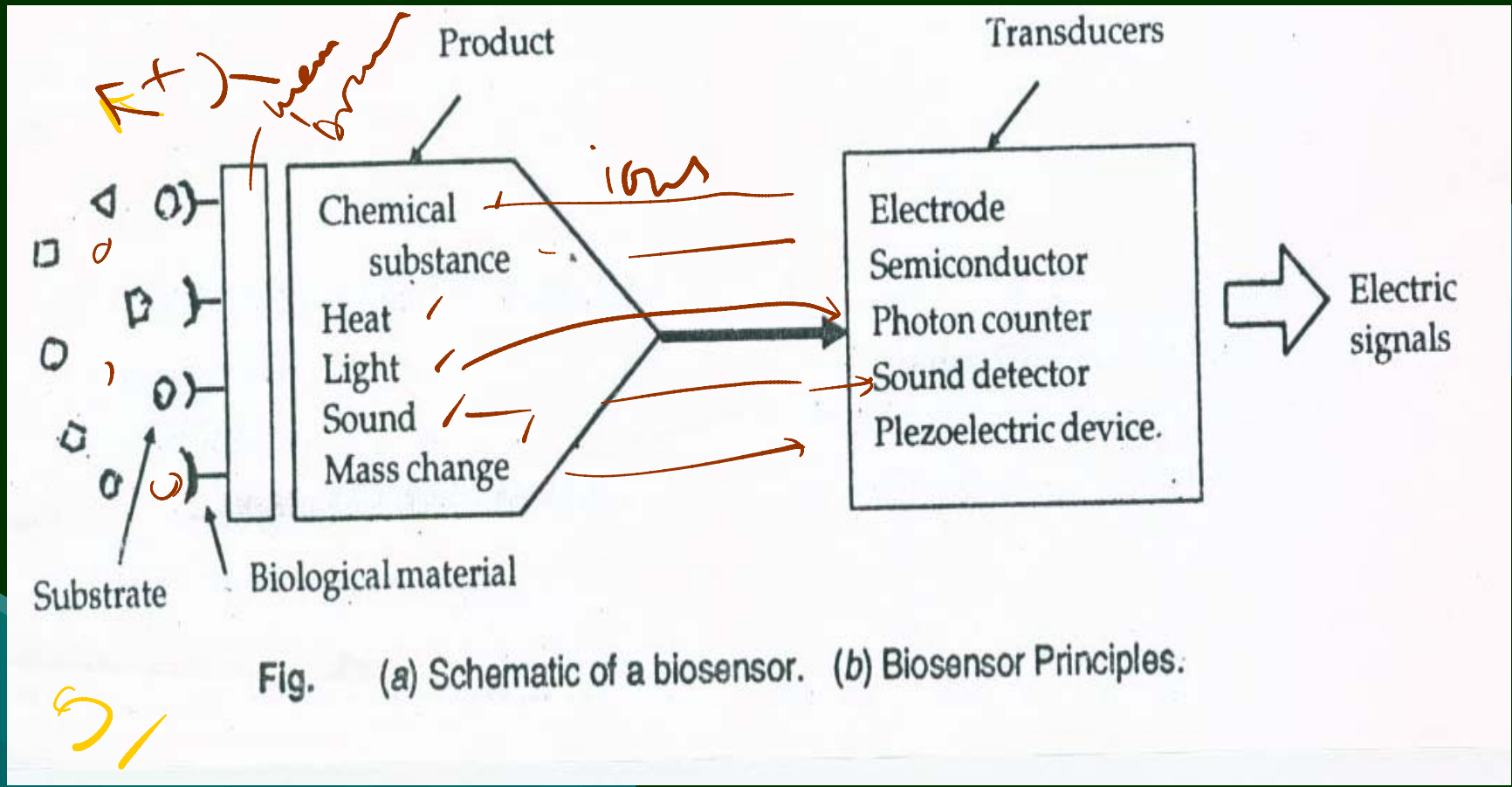
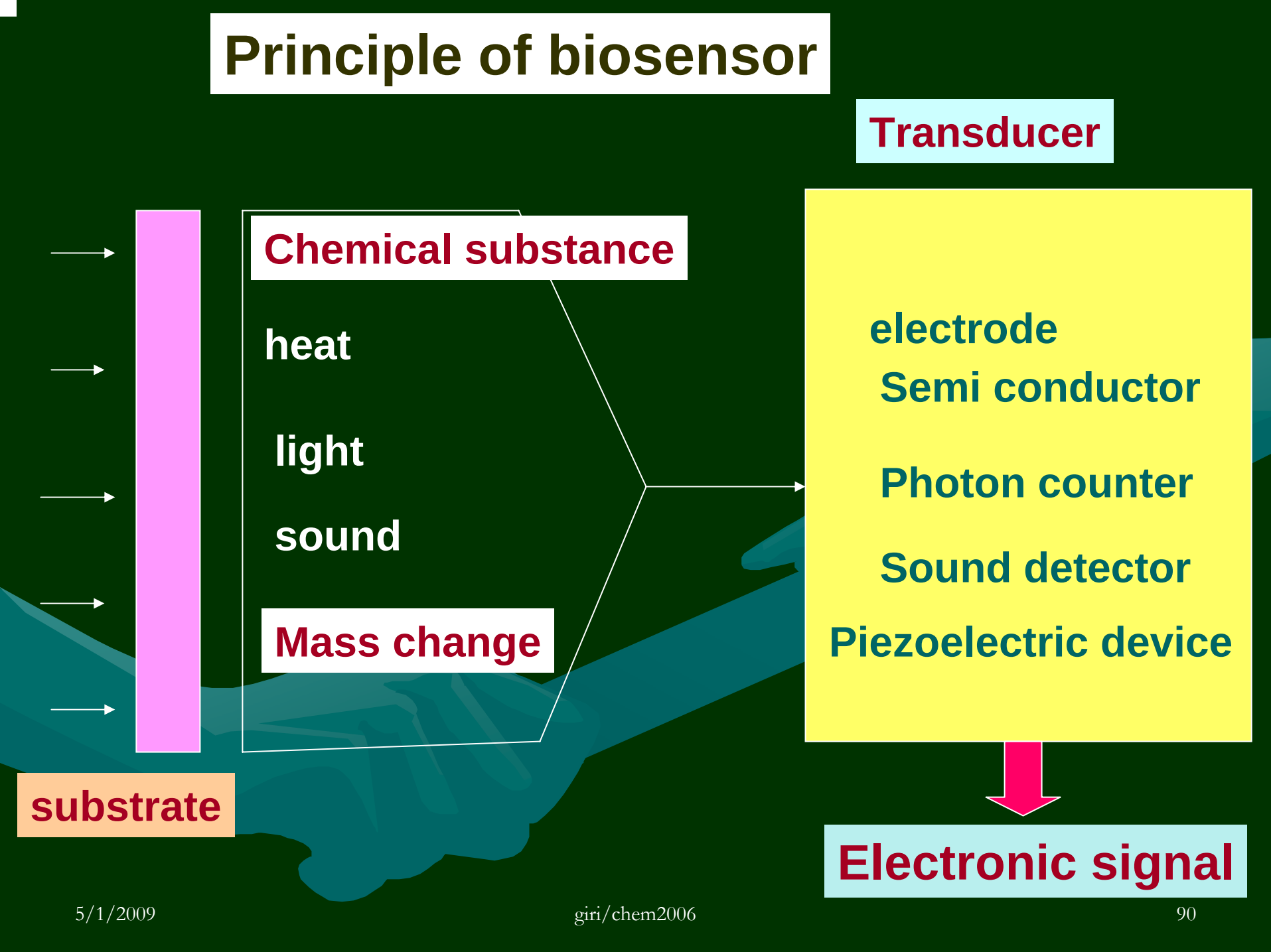


Fig. (a) Schematic of a biosensor. (b) Biosensor Principles.

Principle of biosensor

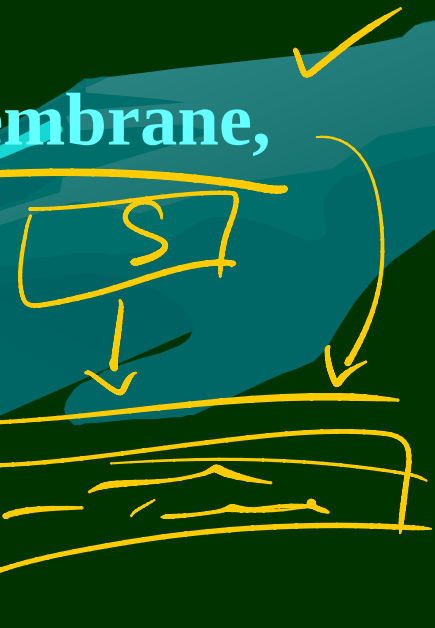


L-48 Biosurf.. & Biosensors

(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.**



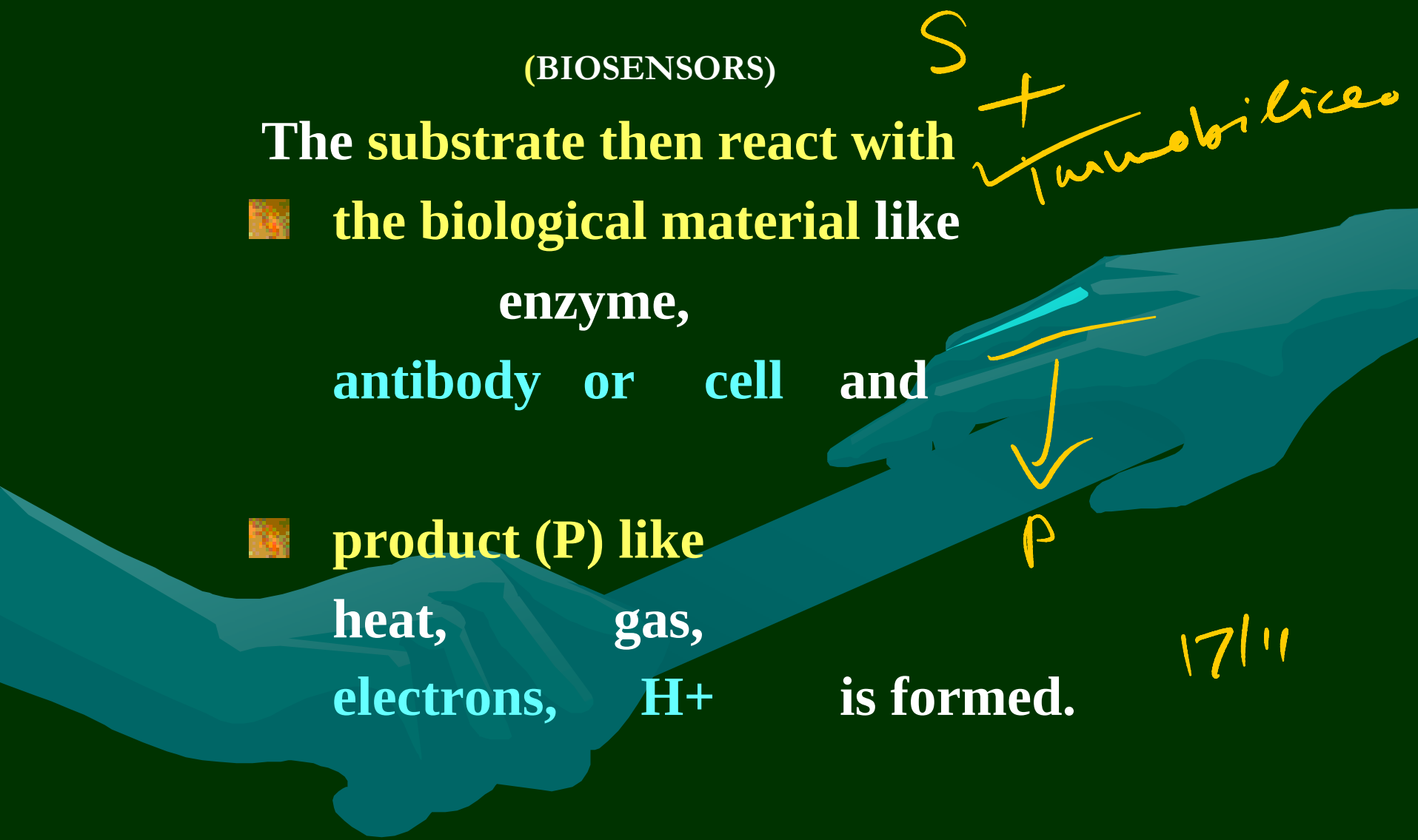
L-48 Biosurf.. & Biosensors

(BIOSENSORS)

The substrate then react with

- the biological material like enzyme, antibody or cell and

- product (P) like heat, gas, electrons, H+ is formed.



L-48 Biosurf.. & Biosensors

(BIOSENSORS)

Or we can say that the

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

L-48 Biosurf.. & Biosensors

(BIOSENSORS)

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

L-48 Biosurf.. & Biosensors

(BIOSENSORS)

Classification of Biosensors:-

the biosensors can be classified into-

1. Calorimetric Biosensors:-

2. Electrochemical Type Biosensors:-

a) Potentiometric Biosensor:-

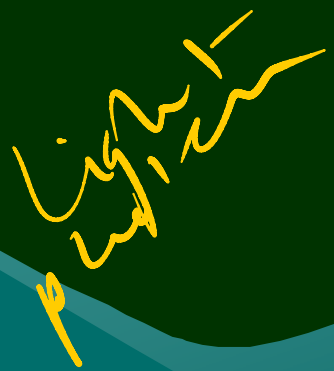
b) Amperometric Biosensors:-

L-48 Biosurf.. & Biosensors

Classification of Biosensors:-

1. Calorimetric Biosensors:-

2. Electrochemical Type Biosensors:-



a) Potentiometric Biosensor:-

b) Amperometric Biosensors:-

L-48 Biosurf.. & Biosensors

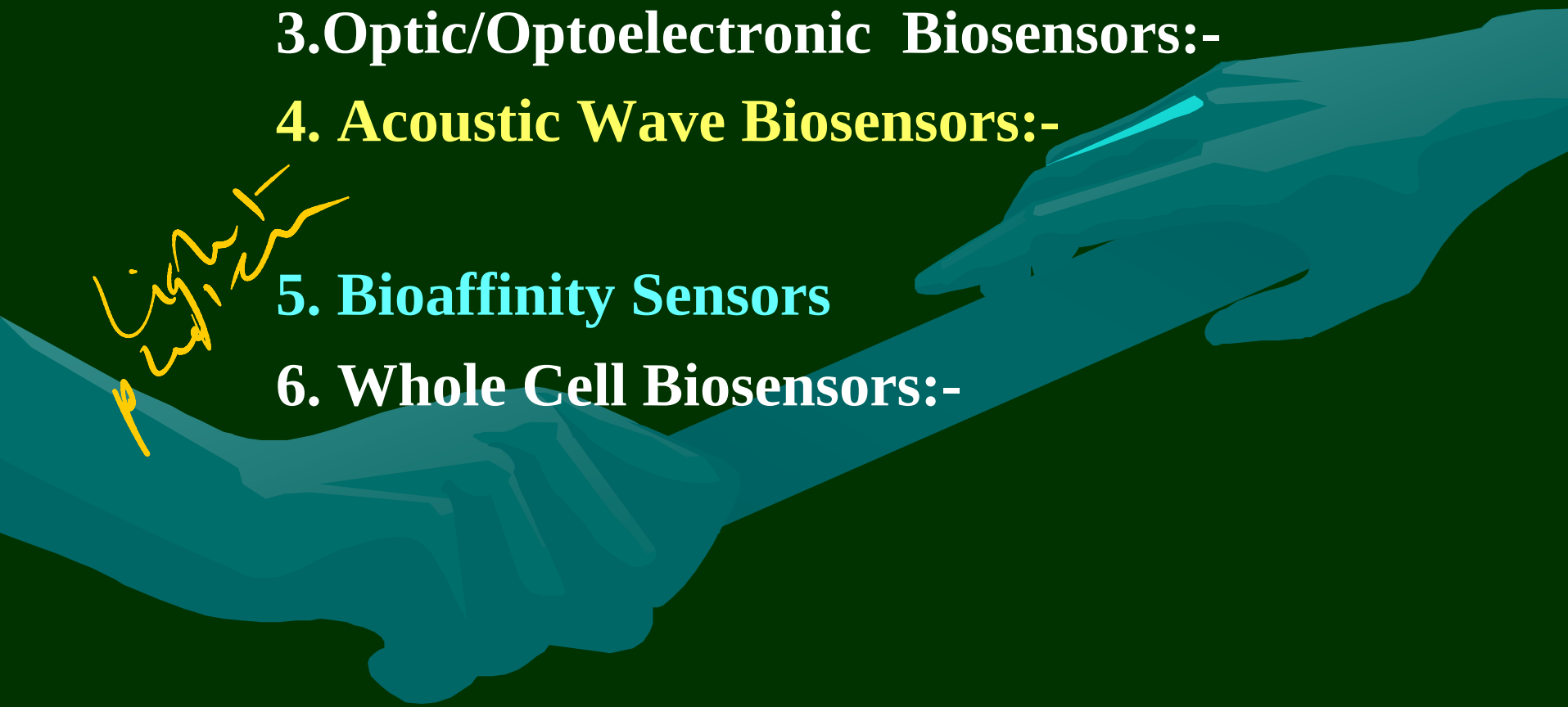
Classification of Biosensors:-

3.Optic/Optoelectronic Biosensors:-

4. Acoustic Wave Biosensors:-

5. Bioaffinity Sensors

6. Whole Cell Biosensors:-



L-48 Biosurf.. & Biosensors

(BIOSENSORS)

1.Calorimetric Biosensors:-

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

L-48 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.

L-48 Biosurf.. & Biosensors

(BIOSENSORS)

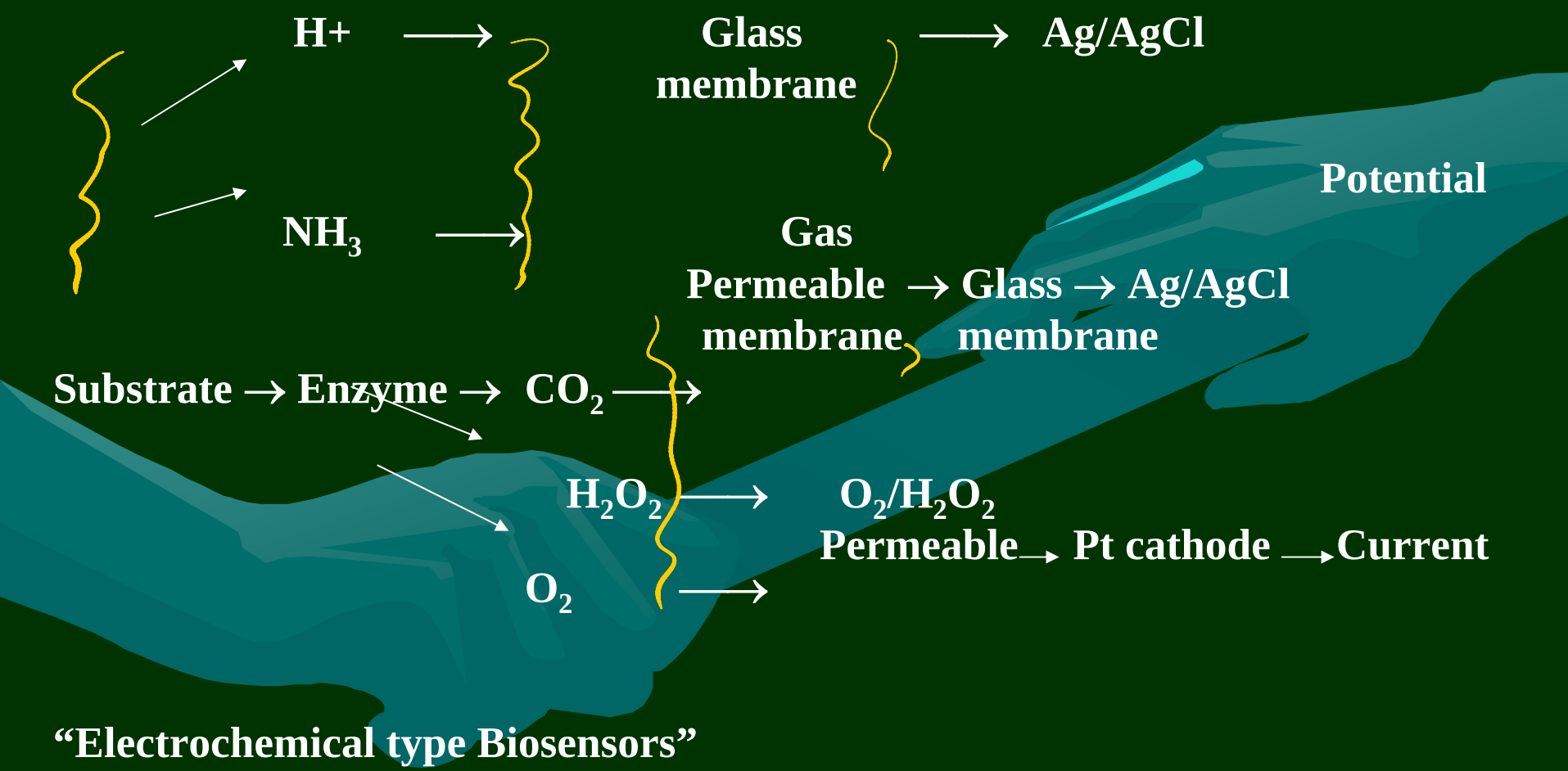
b) Amperometric Biosensors:-

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

L-48 Biosurf.. & Biosensors

(BIOSENSORS)

A brief summery of electrochemical type biosensors are given below-



"Electrochemical type Biosensors"

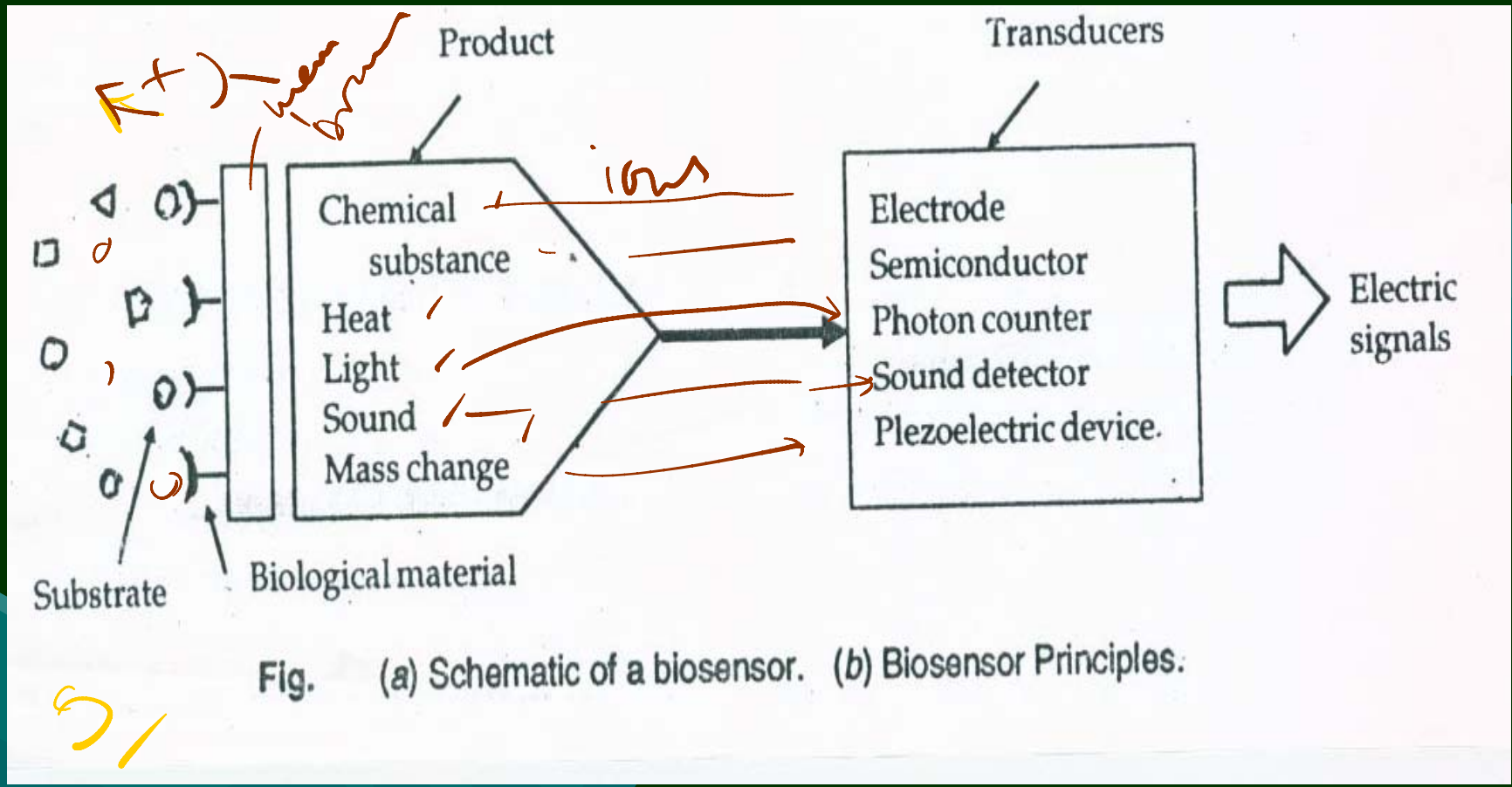


Fig. (a) Schematic of a biosensor. (b) Biosensor Principles.

L-48 Biosurf.. & Biosensors

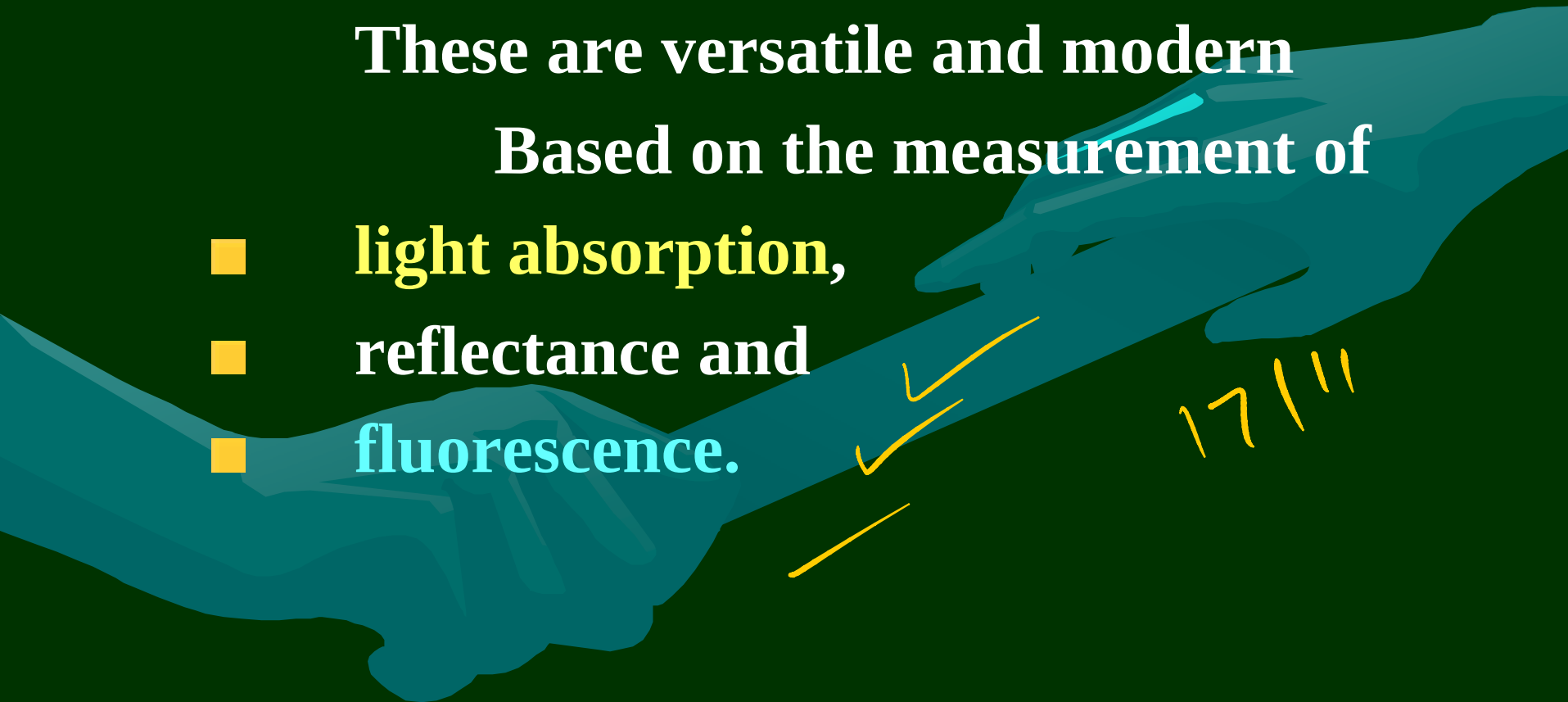
(BIOSENSORS)

3. Optic/Optoelectronic Biosensors:-

These are versatile and modern

Based on the measurement of

- light absorption,
- reflectance and
- fluorescence.



L-48 Biosurf.. & Biosensors

(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.

L-48 Biosurf.. & Biosensors

(BIOSENSORS)

5. Bioaffinity Sensors:-

- These are based on measuring the
- "antibody antigen interactions".

- Labeled antibodies or antigens are used based on
- 'enzyme-linked immunoassay' (EIA).

L-48 Biosurf.. & Biosensors

(BIOSENSORS)

Example of Enzyme – Immunoassay Biosensor

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

L-48 Biosurf.. & Biosensors

(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.

L-48 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:-**

L-48 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.

L-48 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.

L-48 Biosurf.. & Biosensors

(BIOSENSORS)

2.The Laboratory Analyser:-

These are usually

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

L-48 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.
- Requires only a power supply.

L-48 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.

L-48 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.

L-48 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**

L-48 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).

L-48 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).

L-48 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:-

L-48 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**

L-48 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.**

L-48 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:-

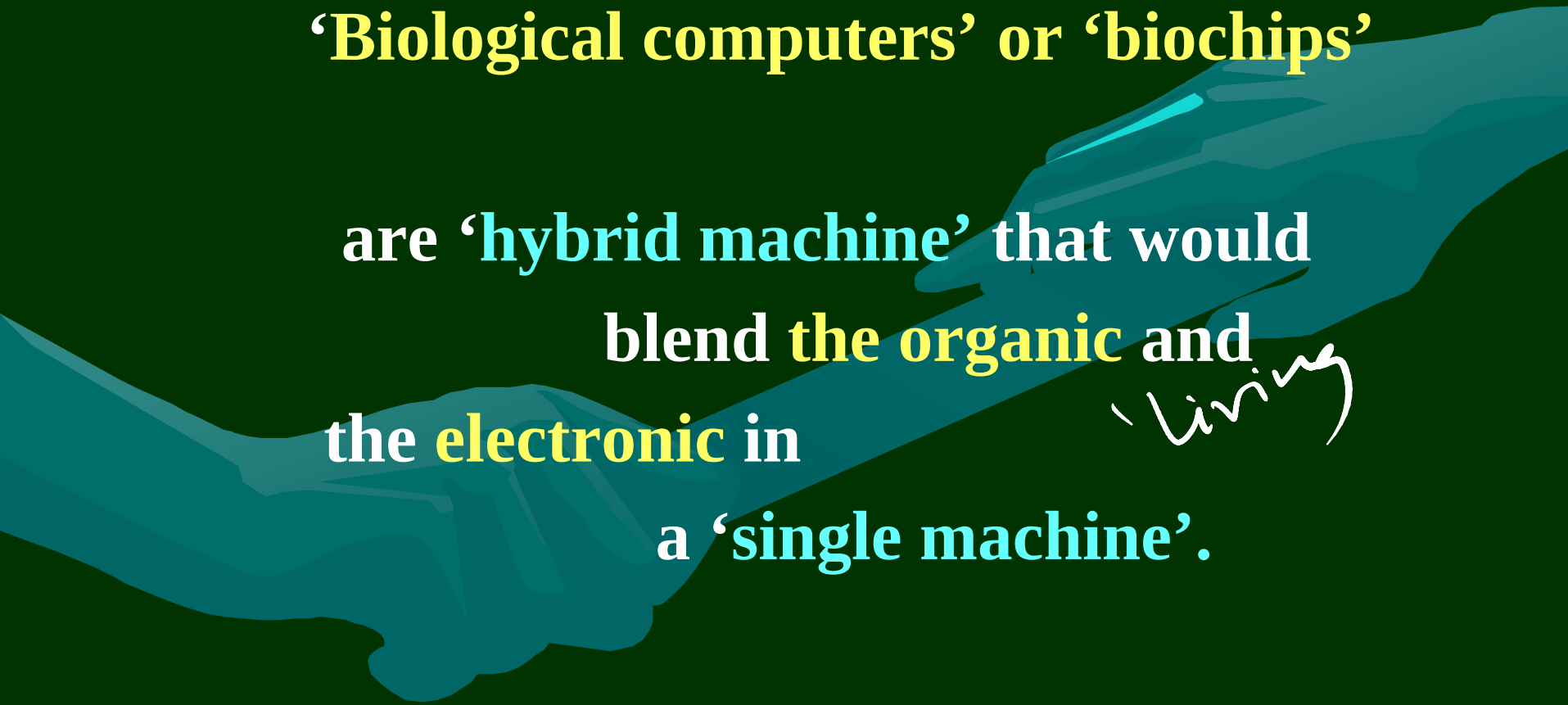
To detect fatigue by measuring levels of lactic acid and ammonia in sweat.

L-59 Biochips & Bioreactors

BIO-CHIPS OR BIOLOGICAL COMPUTERS

'Biological computers' or 'biochips'

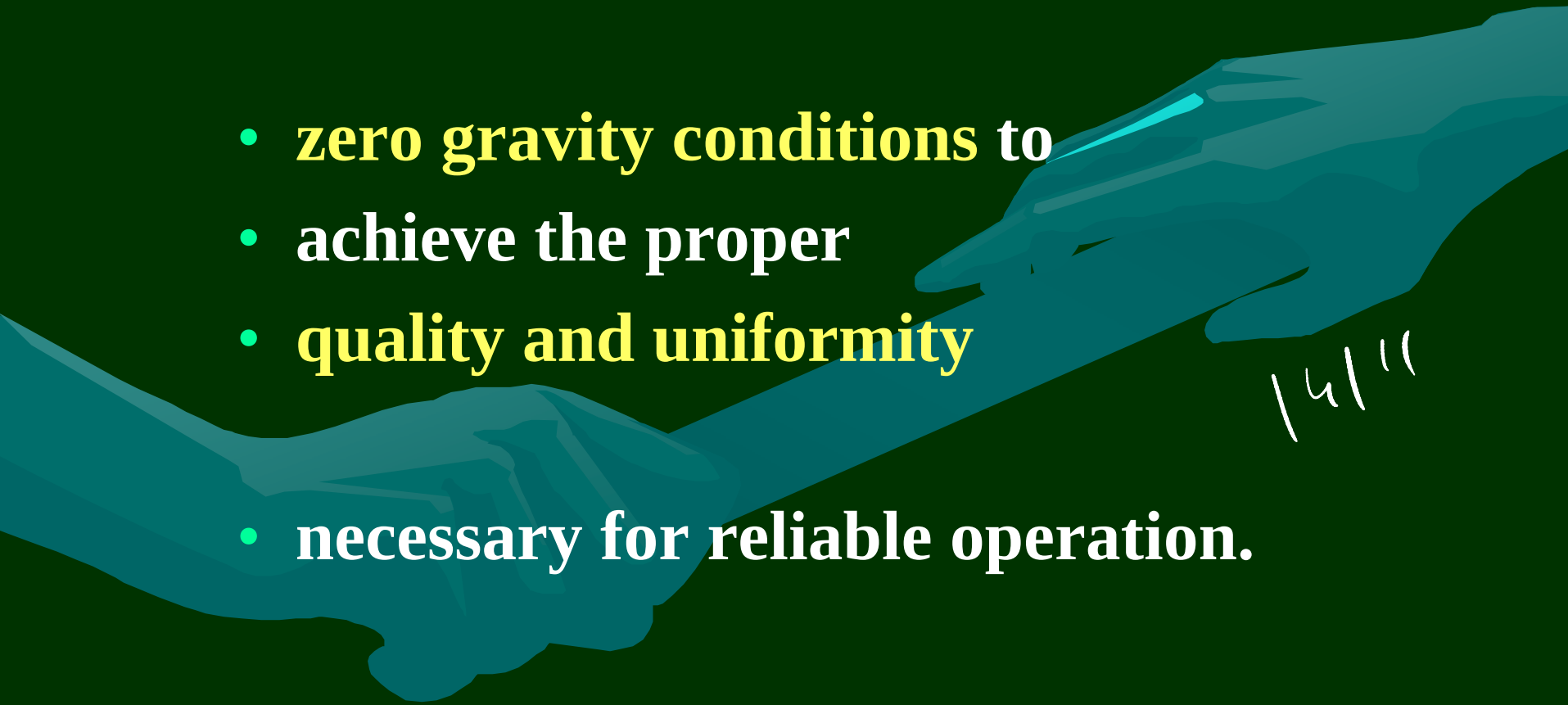
are 'hybrid machine' that would blend the organic and the electronic in a 'single machine'.



L-59 Biochips & Bioreactors

BIO-CHIPS OR BIOLOGICALCOMPUTERS

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



L-59 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.**

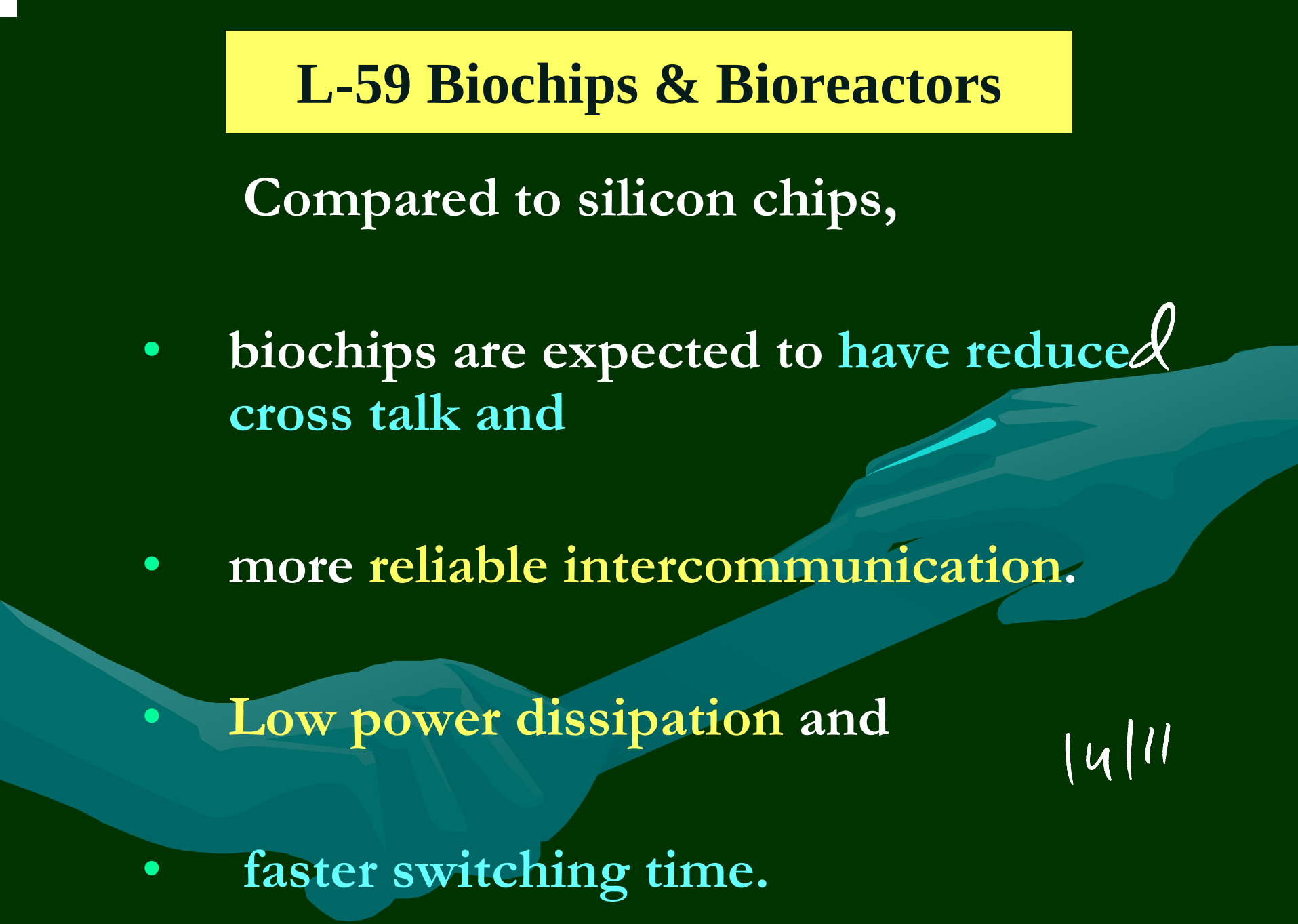
L-59 Biochips & Bioreactors

- 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.

L-59 Biochips & Bioreactors

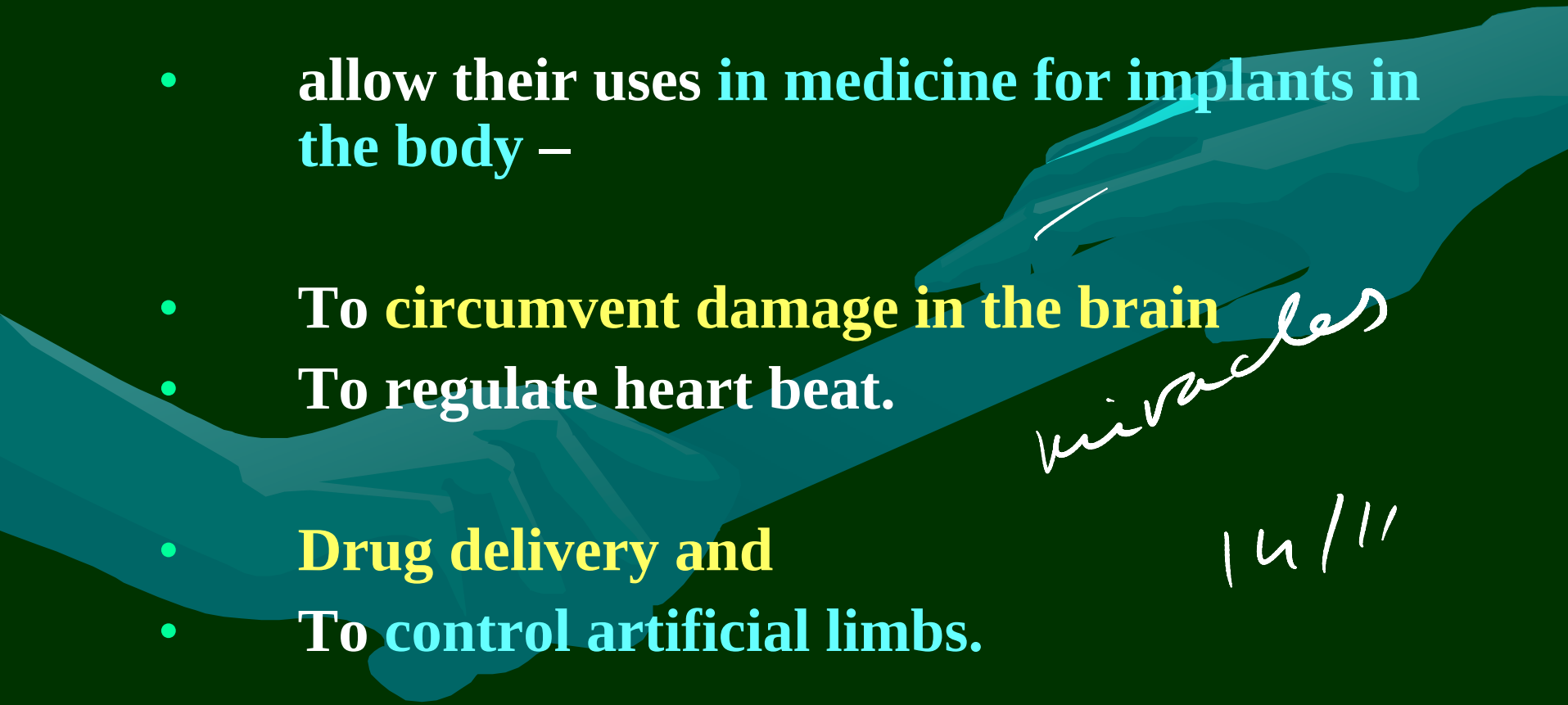
Compared to silicon chips,

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



L-59 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.**



L-59 Biochips & Bioreactors

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

The main components are:

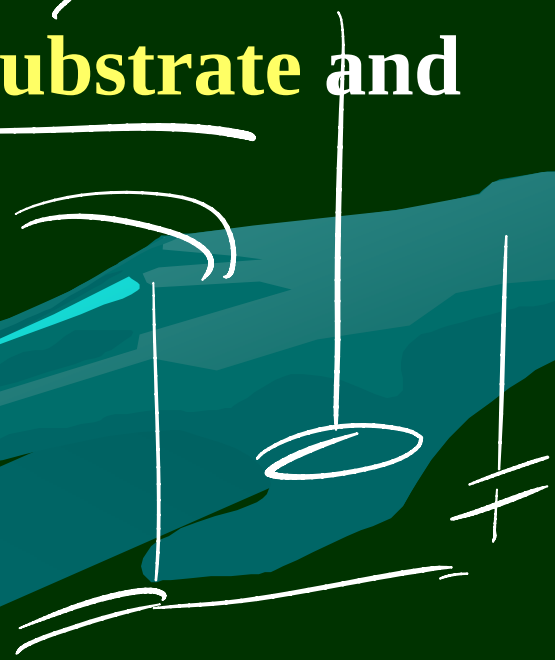
- **Stainless steel or copper tank.**
- **Provision for stirring either manual or**
- **by mechanical agitation.**

L-59 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.



L-59 Biochips & Bioreactors

Types of Bio-reactors:

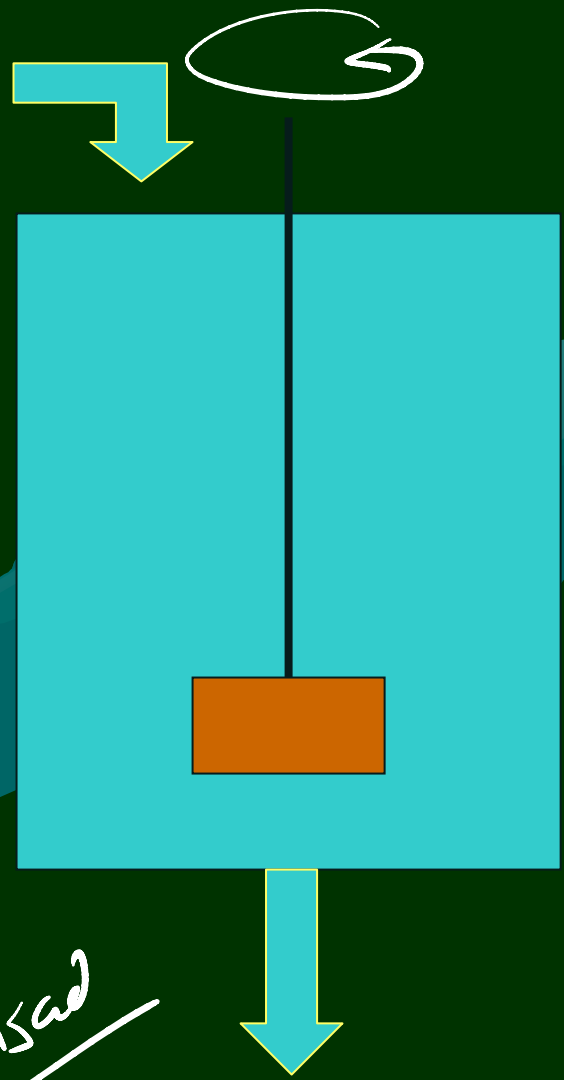
- Mainly five types of bio-reactors are used:-

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

L-59 Biochips & Bioreactors

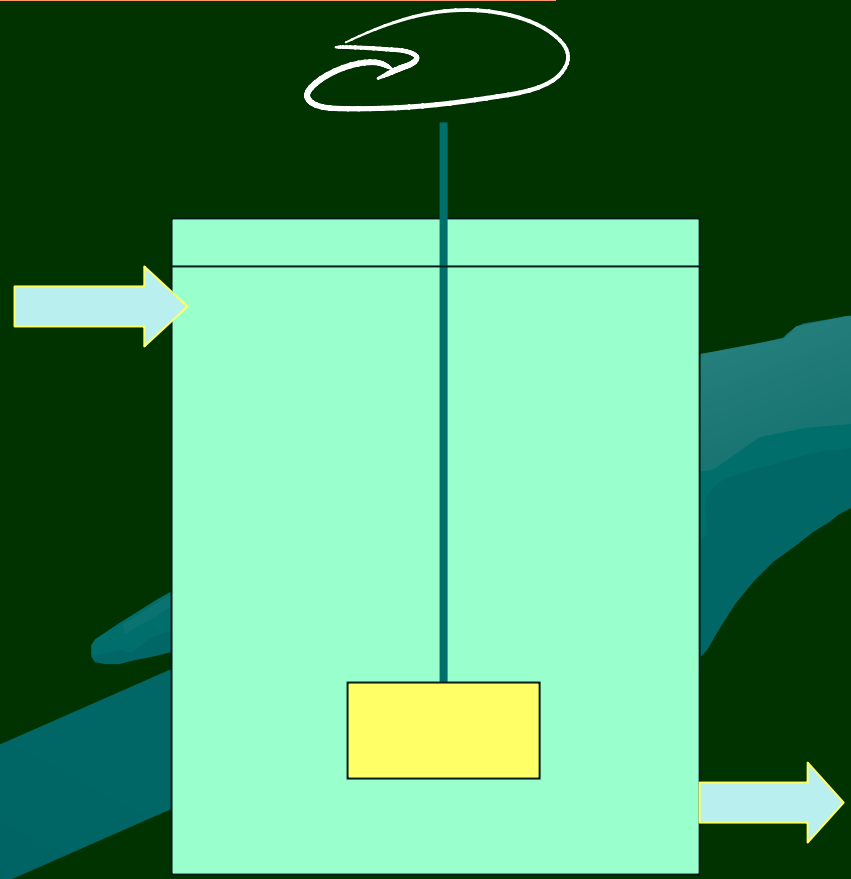
1. **Batch Reactor –**

- 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.



L-59 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

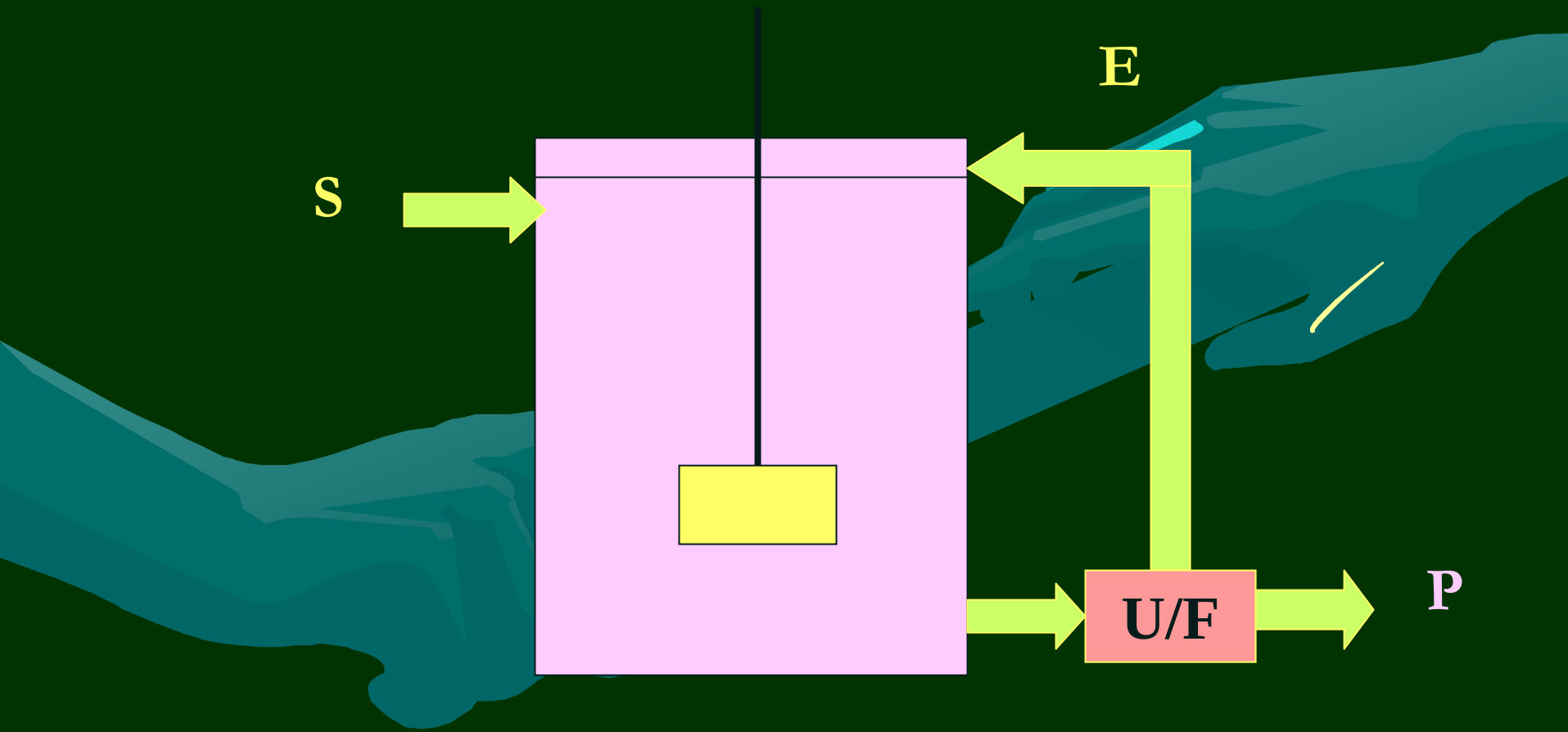
L-59 Biochips & Bioreactors

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

- These are like (ii) discussed above. With following additional characters
- Poor enzymes stability over long term operation.
- Enzyme denatured or absorbed at membrane surface.

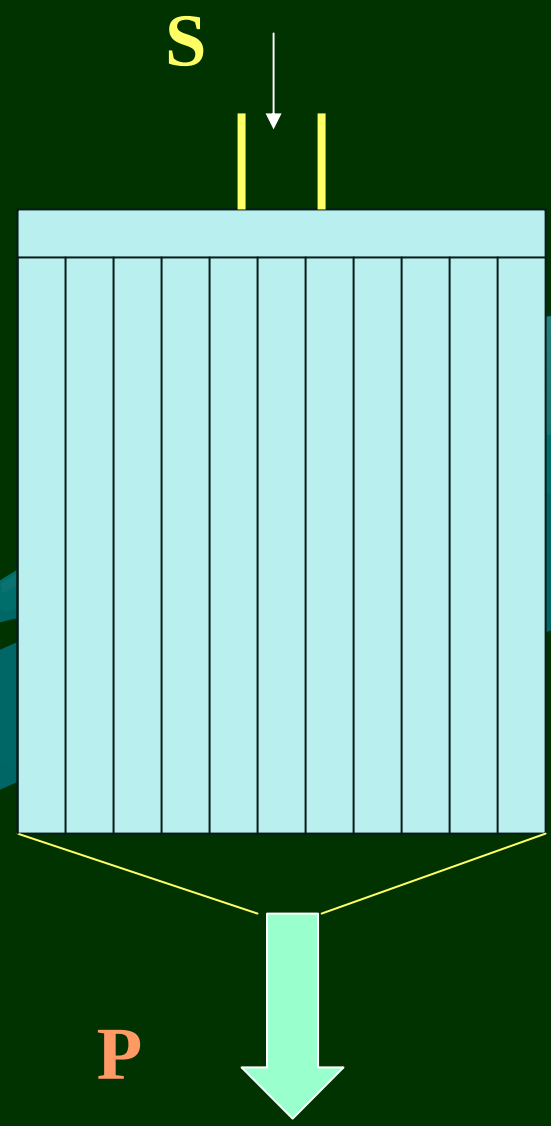
L-59 Biochips & Bioreactors

3. Continuous - Flow stirred tank reactor with ultra filtration



L-59 Biochips & Bioreactors

- **4. Plug – Flow Reactors**



- In these, insoluble enzyme particles are
- packed in a column down which the substrate flow passes.

Pros:

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

L-59 Biochips & Bioreactors

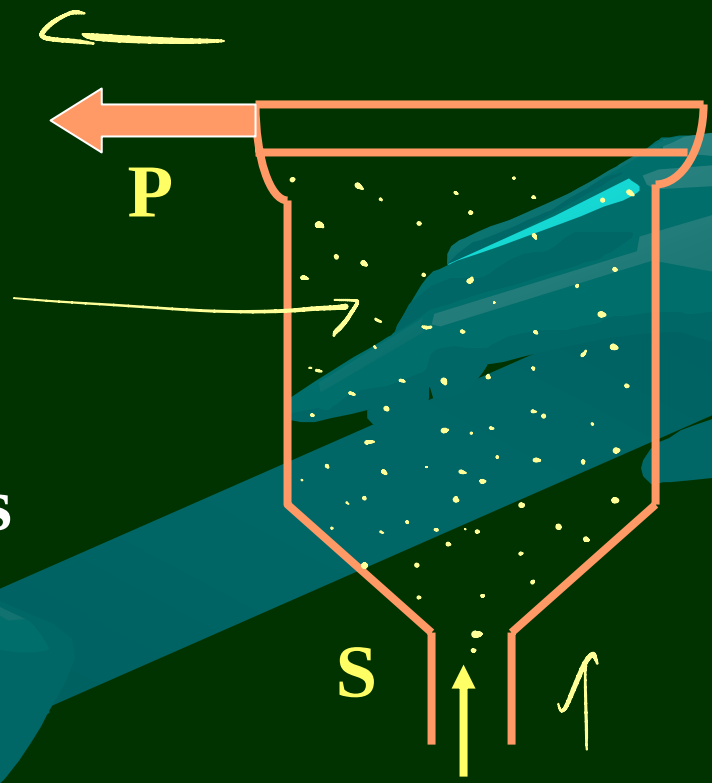
4. Plug – Flow Reactors –Cons:

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

L-59 Biochips & Bioreactors

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

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



L-59 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.

L-50 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…

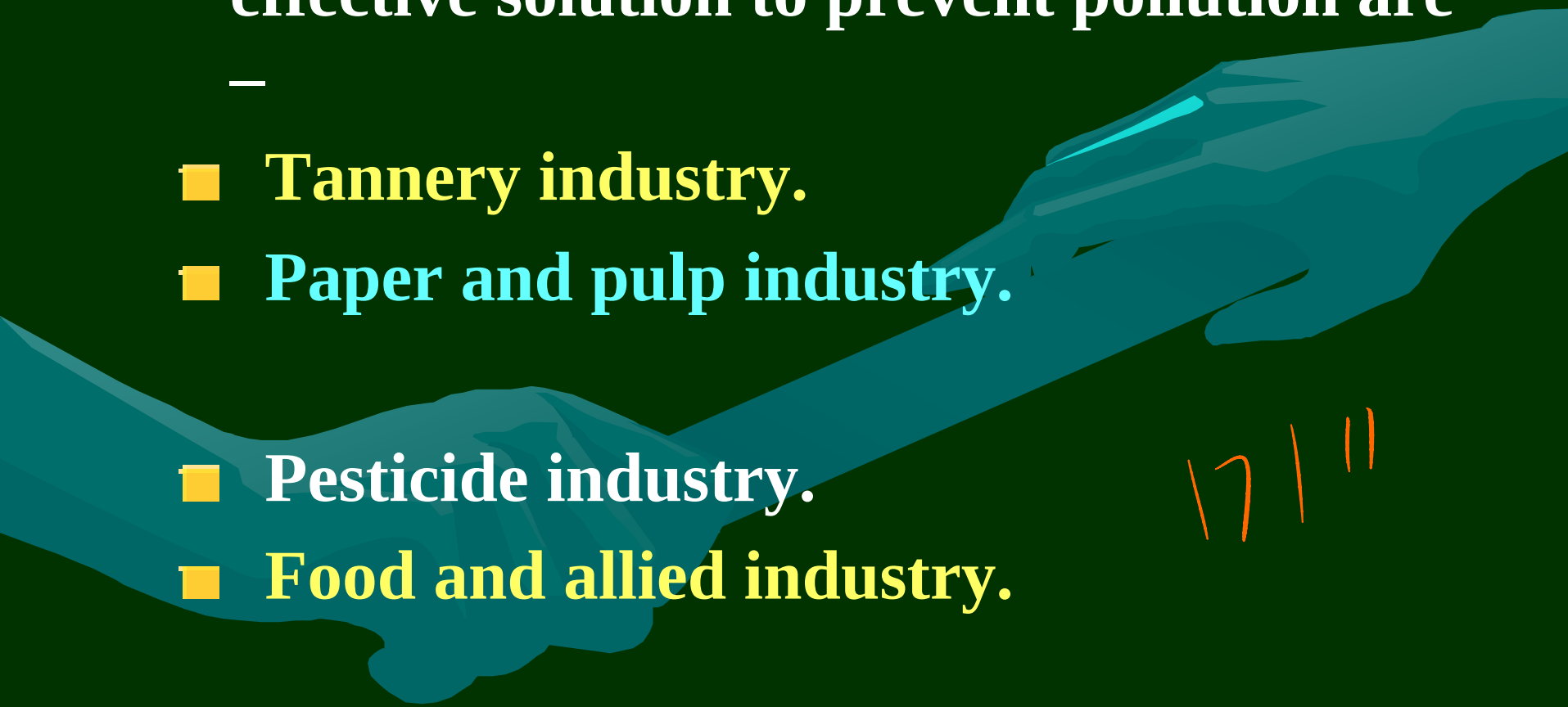
L-50 Pollution prevention in Tannery Ind..

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.

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.



L-50 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,**

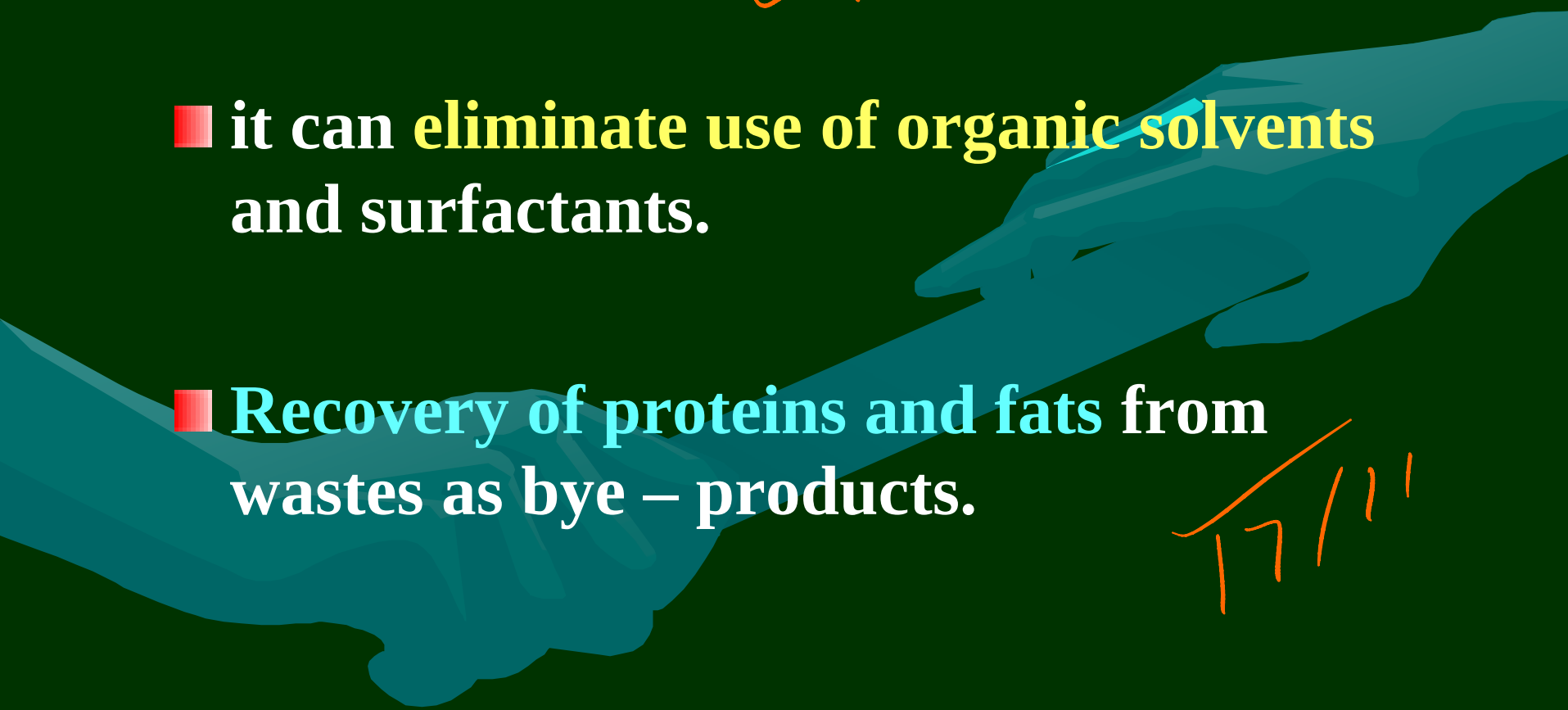
L-50 Pollution prevention in Tannery Ind..

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.

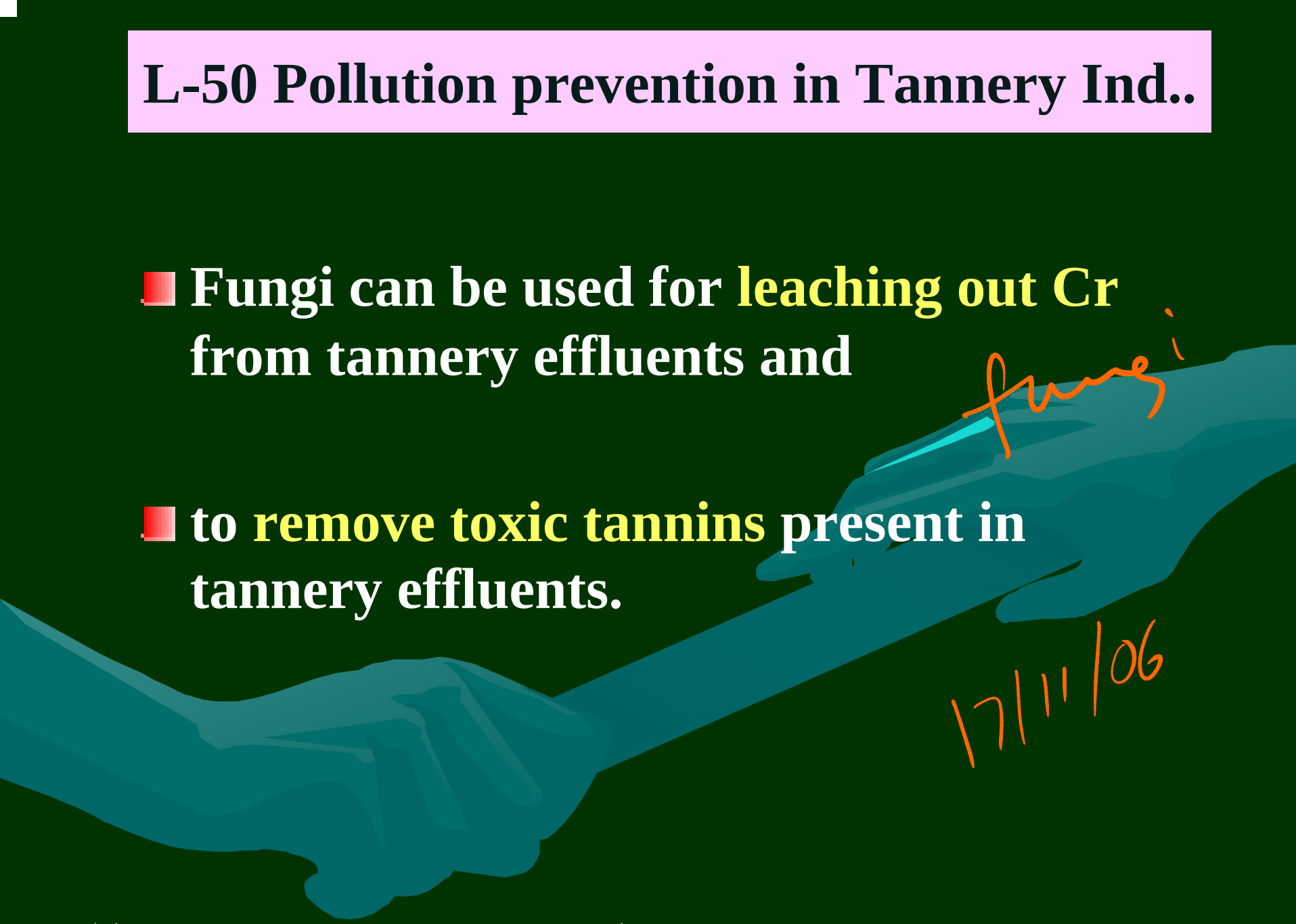
L-50 Pollution prevention in Tannery Ind..

- 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.



L-50 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.



L-51 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.

L-51 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

L-51 Pollution prevention in Paper & Pulp Ind.

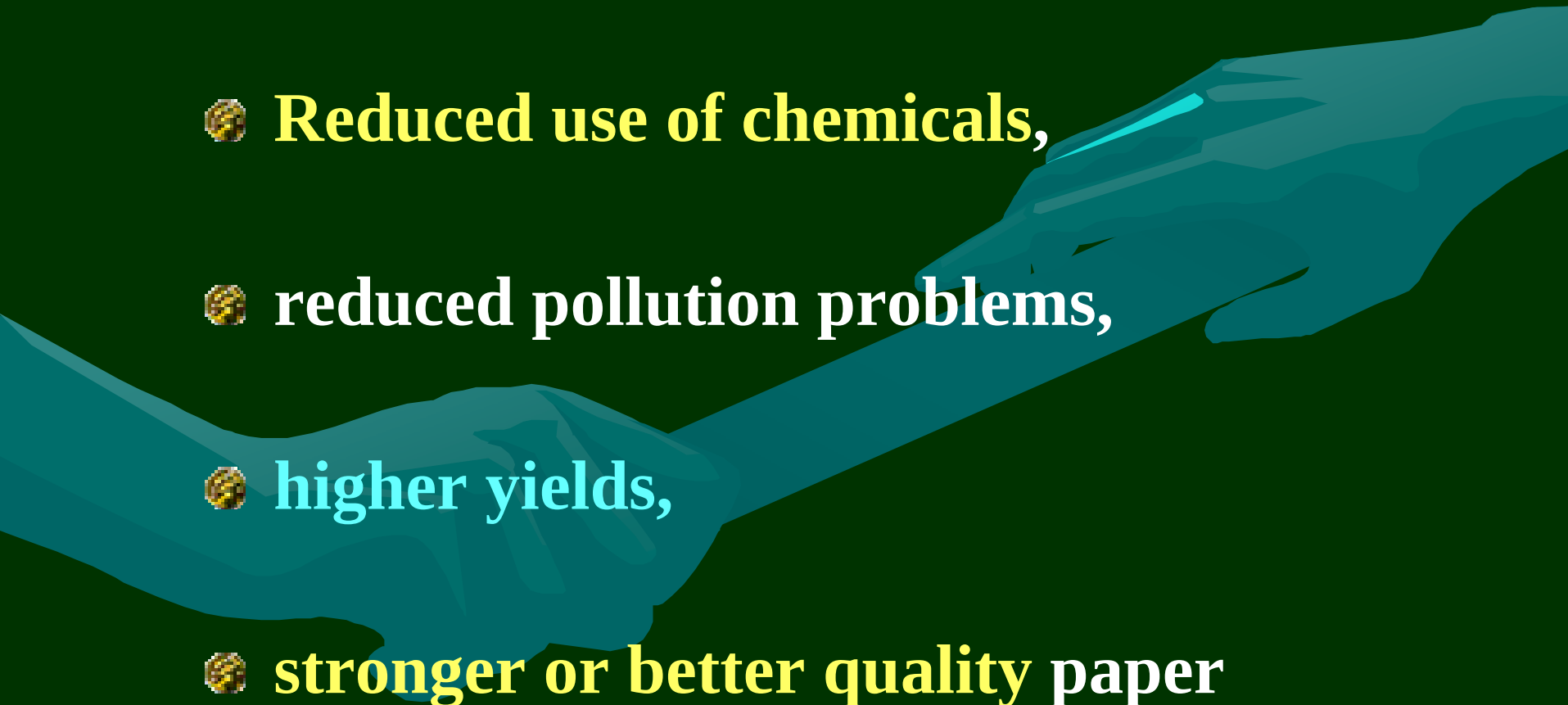
- fungi producing such enzymes to make
- pulp brighter instead of chemical bleaching.
- Ethanol production from 'sludge'.
- Growing yeasts or fungi on sulphite waste liquors.
- Discolouration of pulp mill waste liquors with the help of fungal biomass, or

L-51 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.

L-51 Pollution prevention in Paper & Pulp Ind.

Advantages with biotechnological applications.



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

L-52 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, …..

L-52 Pollution prevention in Pesticide Ind.

(Pesticide Industry)

- Manufacture and use of biopesticides for specific 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.

L-52 Pollution prevention in Pesticide Ind.

But till we get success in

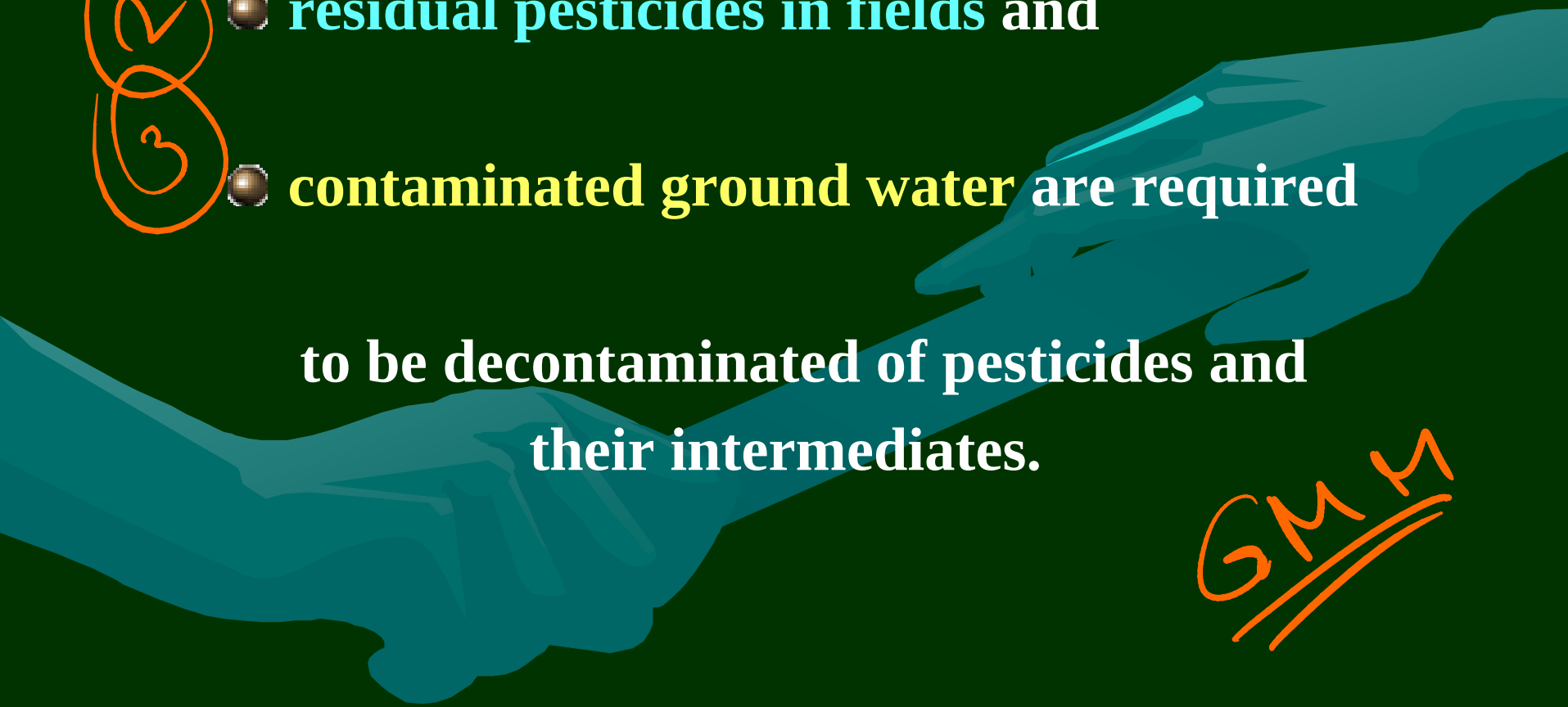
- **prevention of pollution,**
- **treatment technologies to**
- **efficiently eliminate pollutants**

needs to be seriously examined.

L-52 Pollution prevention in Pesticide Ind.

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

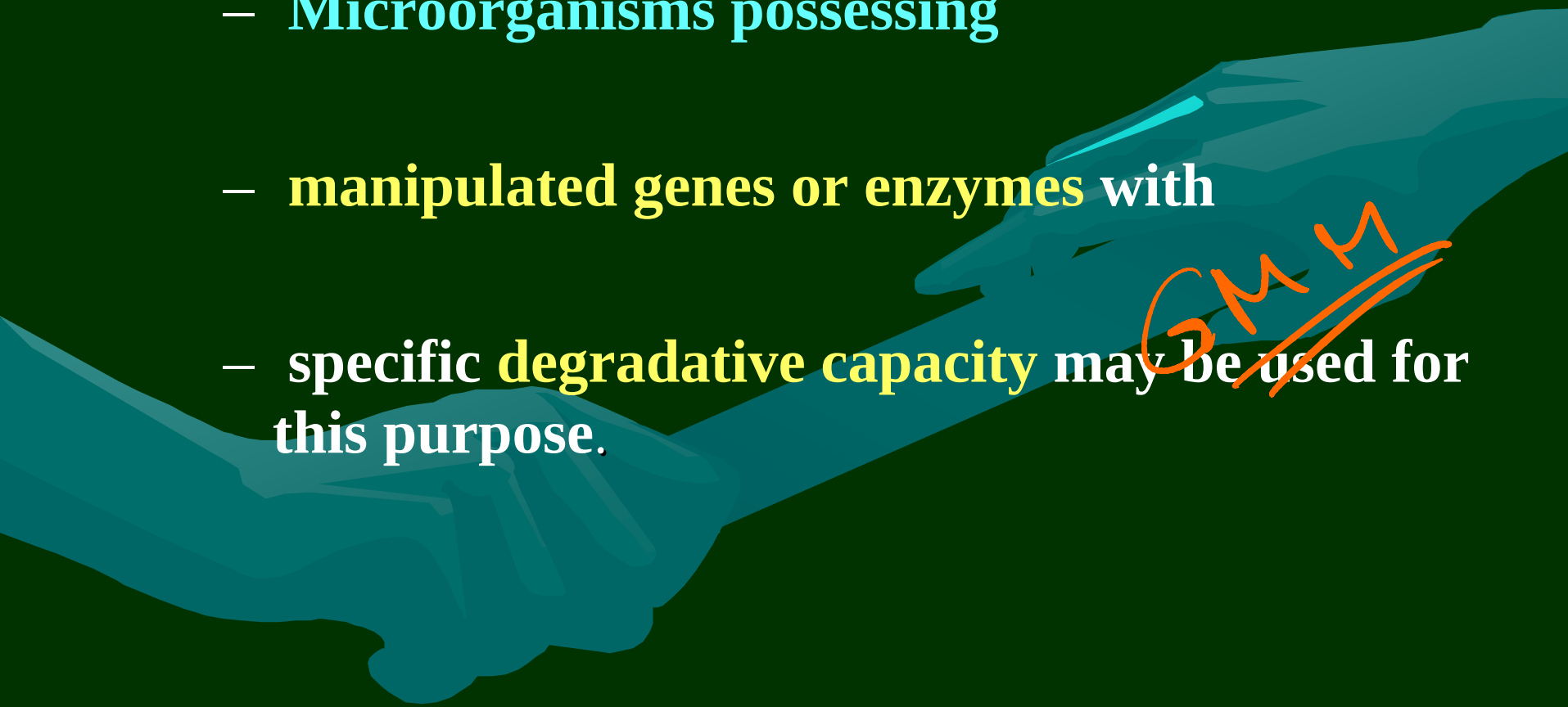
to be decontaminated of pesticides and their intermediates.



L-52 Pollution prevention in Pesticide Ind.

to be decontaminated of pesticides and their intermediates.

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



L-52 Pollution prevention in Pesticide Ind.

There are various reports of use of enzymes like

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

for detoxification of pesticides.

L-52 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.

L-52 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.**

L-52 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

L-52 Pollution prevention in Food & Allied Industries.

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

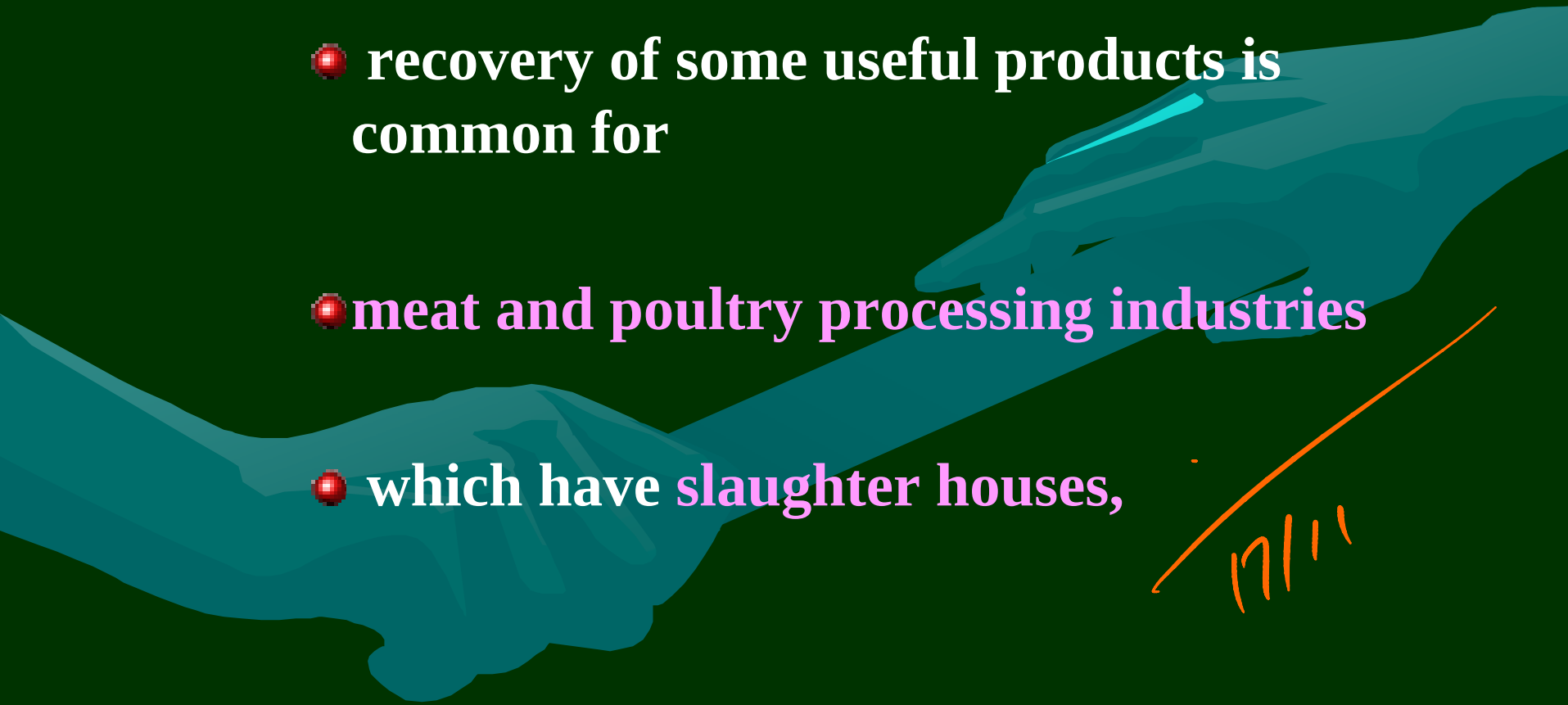
Solid wastes is a problem in

- fruit,
- vegetable,
- meat and
- poultry

processing industries.

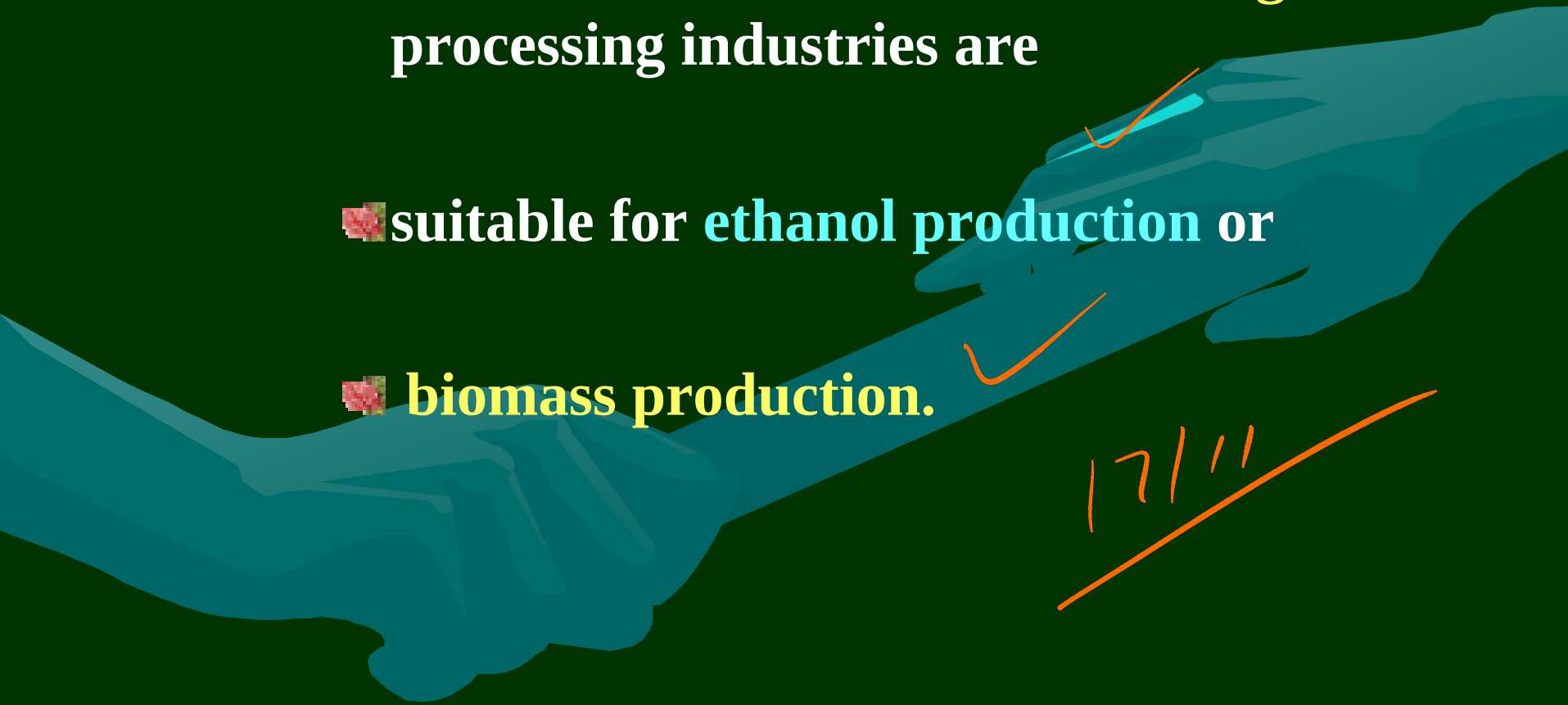
L-52 Pollution prevention in Food & Allied Industries.

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



L-52 Pollution prevention in Food & Allied Industries.

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




Absolute
2004
THANKS

please dont Mug
Do Self Studies
Also…For a better
Future..