
WELCOME

Fermentation Products

Presented by:Reem Saad
Under Guidance of
Prof.FATMA SONBOL
Diploma Microbiology 2020/2021

OUTLINES

- Fermentation products
- Development of fermentation products
- Patent protection
- Fermentation&Why use..
- Fermentation media
- Fermenter&Inocula
- Problems in Fermentation Products
- Safety&Sterilization

Fermentation Products

- Fermentation products are those whose production involves the action of microorganisms or enzymes which cause desirable biochemical changes and significant modification to the product.
- Substances produced from Fermentation which is an anaerobic process. They don't need oxygen to be formed and sometimes this process called anaerobic respiration, that is in contrast with aerobic cellular respiration, which needs oxygen to run.
- It typically occurs in prokaryotes—cells with no nucleus and no mitochondria. Prokaryotes do have cytoplasm. This is where the reactions occur.

Types Of Fermentation Products

-1Microbial Cell (Biomass)

-2Microbial Enzyme

-3Microbial Metabolites

-4Biotransformation

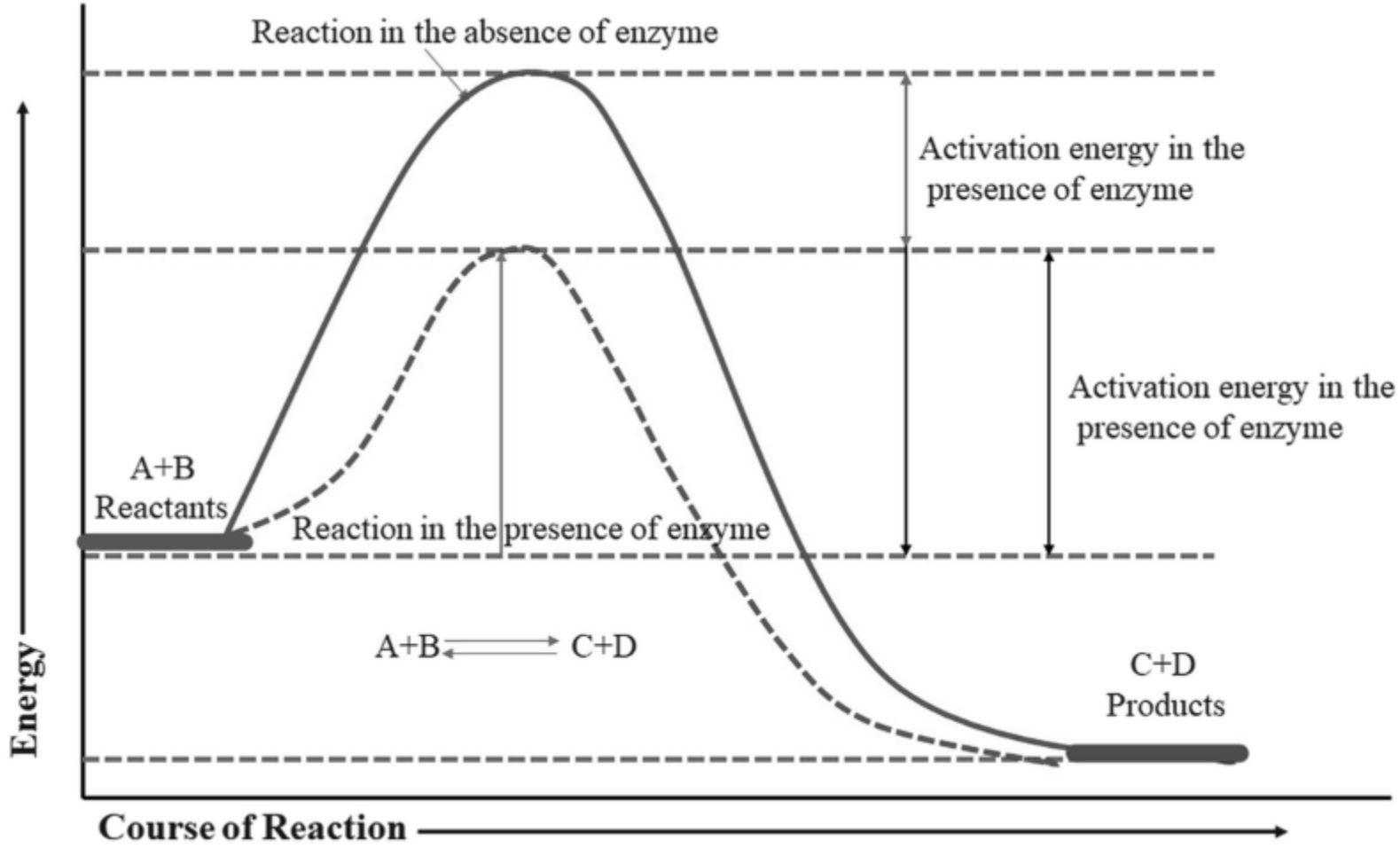
-5Recombinant Products

-1Microbial Cell (Biomass)

- Example of product: Single cell protein (SCP)
- Microbes used for SCP production:Spirulina maxima, Aspergillus niger
- Used in: Animal Feeds, Spirulina, Protein Supplements

-2Microbial Enzyme

- Enzymes are very large, complex protein molecules consisting of intertwined chains of amino acids
- Enzymes formed within the cells of all living creatures
- The enzymes derived from the microbial origin are more active and stable than plant and animal enzymes that is considered as potentially interesting candidates for industrial uses because of the **ease of culturing substantial quantities in a short span of time** ,esrevid ylbidercni no noitatnemref yb **easy to produce** fo egnar ediw a ,**inexpensive** ylidaer dna **available** nobrac .secruos negortin dna


Reaction in the absence of enzyme
Activation energy in the presence of enzyme
Activation energy in the presence of enzyme
A+B
Reactants
Reaction in the presence of enzyme
A+B ⇌ C+D
C+D
Products
Energy
Course of Reaction

-3Microbial Metabolites

Primary metabolites

- Typically formed during the growth phase as a result of energy metabolism
- Are deemed essential for proper growth
- Examples: alcohols, lactic acid, amino acid

Secondry metabolites

- Typically formed during the end or near the stationary phase of growth
- Do not play a role in growth, development and reproduction like primary metabolites Examples: atropine, antibiotics

-4Biotrasformation

- Biotransformation is abiological process whereby an organic compound is modified into reversible product.
- The process involves simple, chemically defined reactions catalyzed by enzymes present in the cell.
- Example: production of **Vinegar**)The oldest and most established transformation process(

-5Recombinant Products

- Once a recombinant DNA is inserted into bacteria, the bacteria will make protein based on this rDNA (known as recombinant protein)
- Example: insuline, hepatitis B vaccine, interferon, streptokinase

The Development of Fermentation Product depends on many factors

-1The **market**.

-2The current level of **Scientific Knowledge**.

-3The **Regulatory Environment.**

-1Market

- The market is affected by product uniqueness and where a market is perceived to exist for a new product, referred to as ‘**market pull** lliw ereht ,’ VIH ,srecnac taert ot sgurd .g.e ,ehcin taht llfi dna yrt ot evitnecni na eb .cte ,aitnemed ,noitcefni
- In medical products, new treatment for a previously untreatable disease or a more effective drug can be **profitable** ezis tekram eht ,oslA.ynapmoc a rof ton sesaesid erar fo sgurd tnempoleved,elpmaxe roF .noitaredisnoc ni si ,UE eht dna ,napaJ, ASU nI .seinapmoc laicremmoc rof elbaiv yllacimonoce ‘ derosnops-tnemnrevog hguorht deveihca tnempoled**orphan drug** ’ programmes.
- When the market cannot afford the product, as in developing countries.International agencies such as the United Nations may be involved in supplying the products.

-2The level of scientific knowledge

- Some advances in science result in rapid development of industrial processes,termed '**scientific push**.'
- For example, **Fleming's discovery of penicillin**1928 ni led to establishment of antibiotic industry in 1940s.
- The rapid progress of **recombinant DNA technology**' a detareneg osla push ' for many new products.
- Some major markets exist at present **science cannot produce the necessary product** fo tnemtaert eht rof sgurd dna eniccav VIH evitceffe na .g.e , .cte,esaesid traeh ,sredrosid latnem,srecnac

Patent protection

- **Patent protection** ni ,egats ylrae na ta thguos yllamron si noitnevni na fo sti morf srehto edulcxe ot thgir lagel eht eetnetap eht evig ot redro 20 –17 yllausu fo doirep a rof esu laicremmocyears, depending upon the country.
- Patents can be separated into three distinct types:

–1Product patents

–2Manufacturing process patents

–3Methods of use patents

-1Product patents

-)substances, composition of matter and devices) such as bioinsecticides,recombinant proteins,monoclonal antibodies, plasmids, etc. are most readily protected as patent infringement can be determined by product analysis.

-2Manufacturing process patents

- E.g.DNA isolation, purification of a recombinant protein,etc., presuppose an improved method of production and are rather more difficult to enforce.
- Patenting of microorganisms, has been carried out for over a hundred years.However, the patenting of gene sequences and whole organisms, particularly plants and animals, is controversial as it raises enormous legal, economic, environmental and not least ethical and moral issues.

-3Methods of use patents

- Involve a novel role for a product, such as mode of bioinsecticide application, drug delivery, etc

Examples of Fermentation Products

Food Products	Fermented Beverages	Industrial Chemicals
*Milk (yogurt&cheeses) *Fruits(vinegar) *Vegetables (pickles) *Cereal Products (soy sauce&bread(	*Wine (grapes) *Beer (cereal grains)	*Ethanol *Glycerol *Acrylic acid *Textile,leather,rubber

Fermentation products

-1Food Products:

*Milk (yogurt&cheeses)

*Fruits(vinegar)

*Vegetables (pickles)

*Cereal Products (soy sauce&bread(

Fermented Foods:

Beverages

Dairy products

Cereals

Meat&Fish

Fruits&Vegetables

• Contribution of the fermented foods:

-1Enrichment of the human diet.

-2Presentation of substantial amounts of food.

-3Erichment of nutritional value of food (vitamins, proteins, essential amino acids).

-4Detoxification of food (flatulence-causing sugars, lectins, phytates, etc..).

-5Decrease the cooking time and fuel requirements.

Fermented and canned products..

How's it different than canning?

- Fermented and canned products may look similar, but they are quite different.
- Canning uses heat to sterilize food and eliminate or reduce the growth of harmful organisms. As the food is sealed in a can or jar, no harmful organisms or air can get inside, and the food can be stored for a very long period.
- While canning retains most nutrients, some B and C vitamins are lost. Contrarily, fermentation retains and even increases the quantity of many nutrients and healthy compounds

-2Fermented Beverages:

*Wine (grapes)

*Beer (cereal grains)

-3Industrial Chemicals:

-1Ethanol → Solvent → Yeast

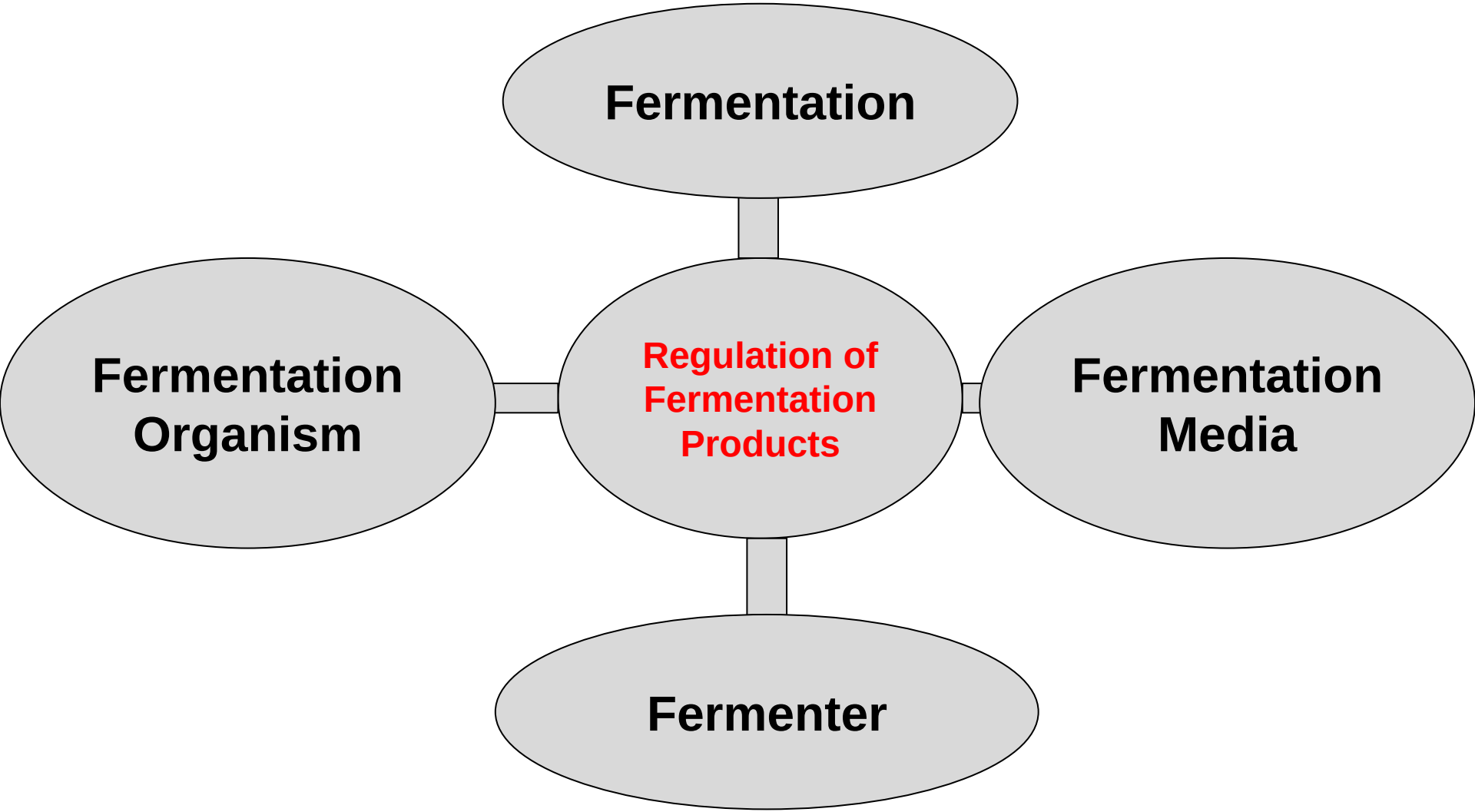
-2Glycerol → plastics,cosmetics,soaps and printing

-3Acrylic acid(Bacillus) → Plastic industry

-4Textile_Dyeing, Leather treatment, Rubber formation → Aspergillus

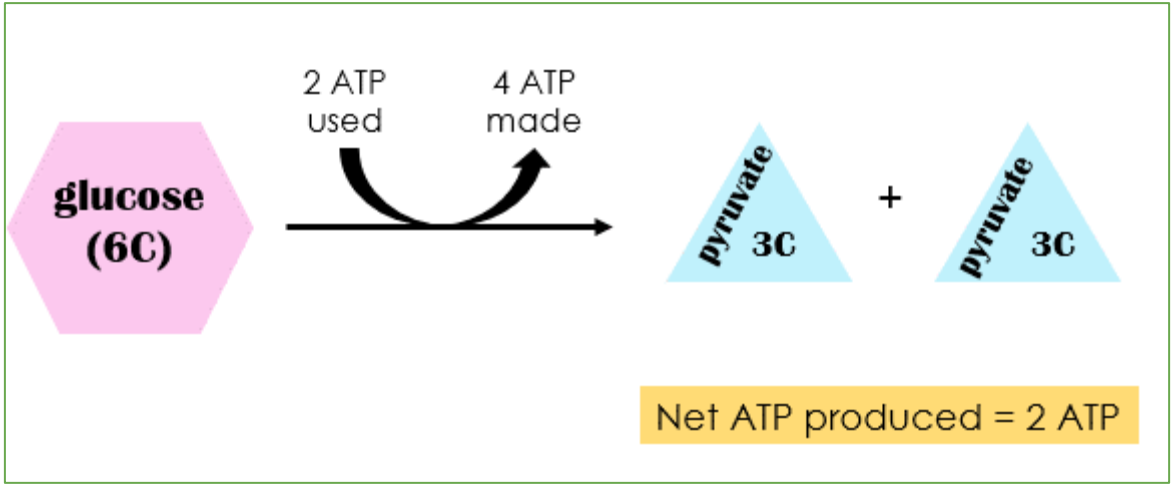
- **Advantages:**

1. Commercial values
2. No need to refrigerate
3. Easy to preserve
4. Easily digestible


Fermentation
Fermentation Organism
Regulation of Fermentation Products
Fermentation Media
Fermenter

Fermentation

- Fermentation, chemical process by which molecules such as glucose are broken down anaerobically. More broadly, fermentation is the foaming that occurs during the manufacture of wine and beer, a process at least 10,000 years old
- It was first observed and studied by Louis Pasteur, who looked at acetic acid bacteria. This is the same guy who developed the process of pasteurization.
- Fermentation is one way for organisms to make energy-rich adenosine triphosphate (ATP).
- There are a few types, but ethanol(alcholic) and lactic acid are the main two.

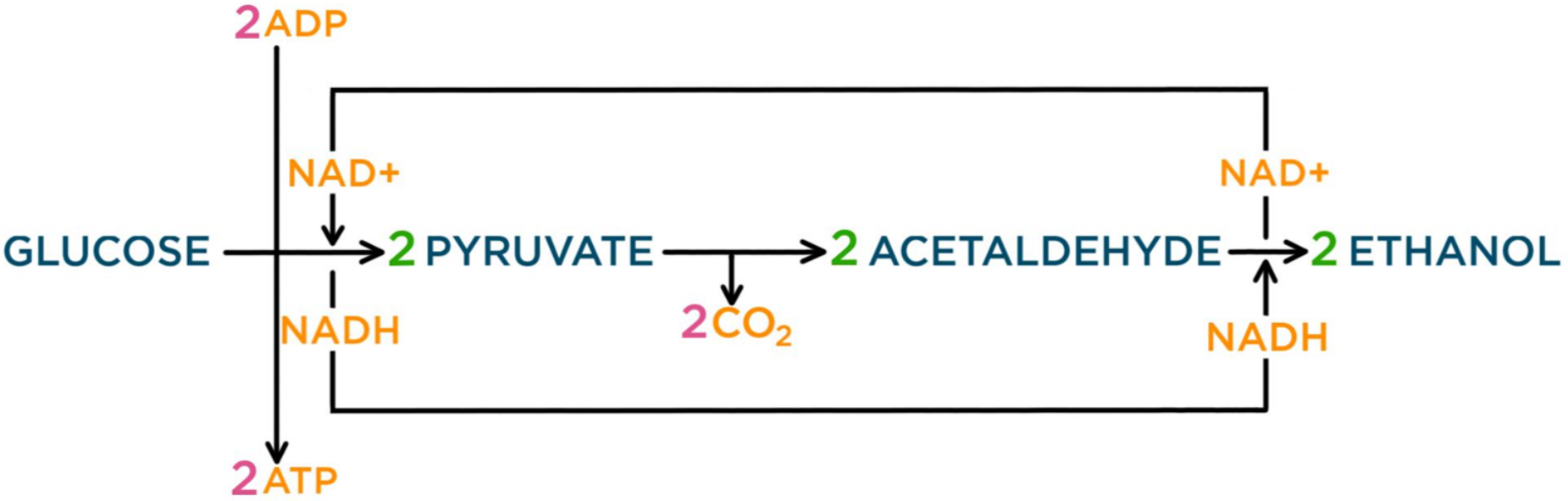

2 ATP
used
4 ATP
made
glucose
(6C)
pyruvate
3C
+
pyruvate
3C
Net ATP produced = 2 ATP

Ethanol Fermentation:

- Ethanol fermentation products include alcohol and carbon dioxide gas.

  As you might have inferred, this is how we make things like wine and beer with the help of yeast cells.

Ethanol Fermentation



Alcohol fermentation produce:

- Prpanol
- Ehanol
- Lactic acid
- Glucose
- Answer Please....

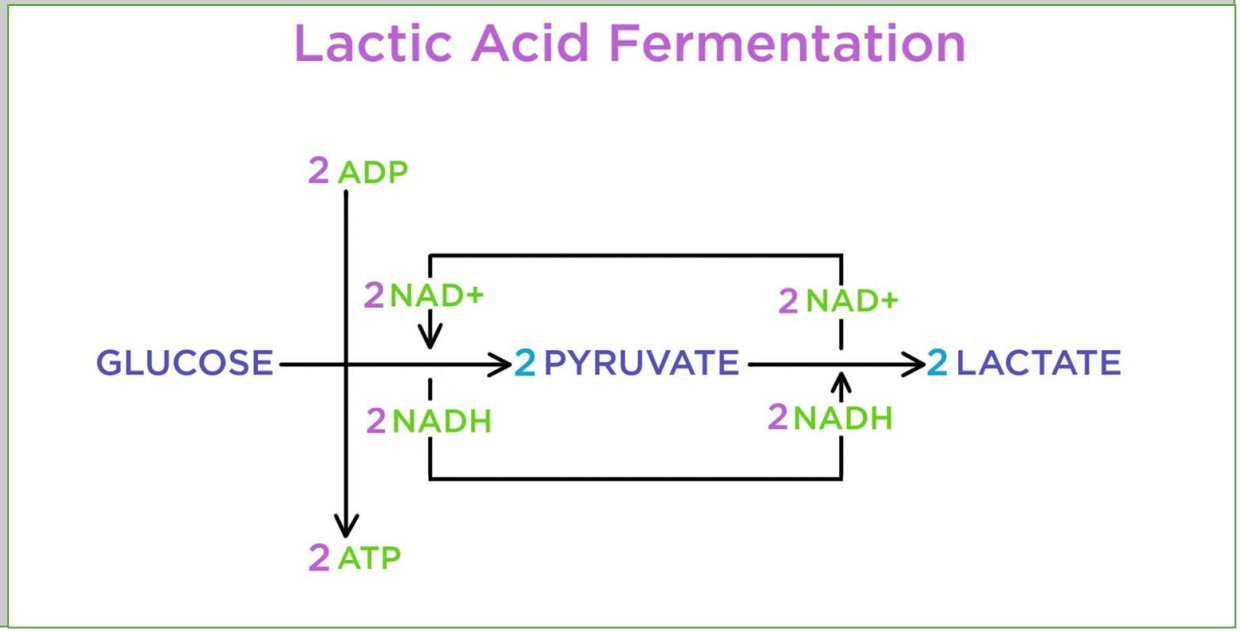
Thanks;

Alcohol fermentation produce:

- ~~Prpanol~~
- Ehanol
- ~~Lactic acid~~
- ~~Glucose~~

Lactic acid Fermentation:

- Lactic acid fermentation produces lactate. Lactate can then be converted into lactic acid.

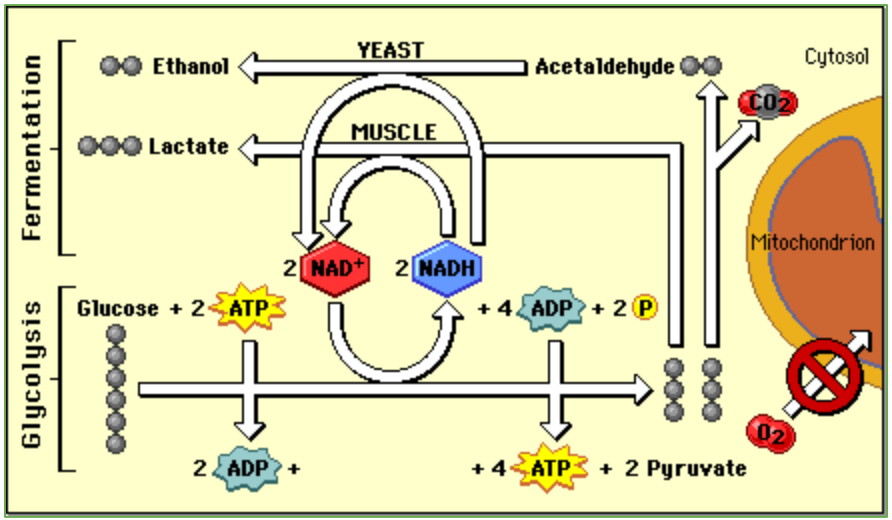


Why use Fermentation?

- Do you like the taste of bread? Kimchi? Pickles? All of these foods (plus a lot more) are products of fermentation.
- This is how organisms generate ATP when oxygen is not available. This is important when cells are performing glycolysis but have no oxygen to complete the Krebs cycle or electron transport chain. The Krebs cycle and electron transport chain are aerobic processes.

Why use Fermentation?

- After glycolysis, there is an excess of ATP that is quickly grabbed by NAD + to become NADH. However, because there is no oxygen to steal the hydrogen atoms, the NADH can not become NAD + again. Once all of the NAD + is NADH, glycolysis and cellular respiration would stop completely. No more ATP can be produced. The whole process grinds to a halt.
- This is where fermentation comes in.


Fermentation
Glycolysis
YEAST
Ethanol
Acetaldehyde
Cytosol
MUSCLE
Lactate
CO2
Mitochondrion
2 NAD+
2 NADH
Glucose + 2 ATP
+ 4 ADP + 2 P
O2
2 ADP +
+ 4 ATP + 2 Pyruvate

Think&Answer

When do organisms use fermentation??

- When there is too much oxygen available
- When there is too much carbon dioxide available
- When there is too little carbon dioxide available
- When there is not oxygen available
- Answer Please....

When do organisms use fermentation??

- ~~When there is too much oxygen available~~
- ~~When there is too much carbon dioxide available~~
- ~~When there is too little carbon dioxide available~~
- **When there is not oxygen available**

Media of Fermentation Products

- **Introduction:**

❖ Fermentation is a metabolic process carried out by some micro-organism in whish sugar is consumed in absence of oxygen and economically important by-products are given out.

❖ In fermentation products the most important things are fermenter, **Fermentation Media**snoitidnoc mumitpo dna msinagro noitatnemref ,

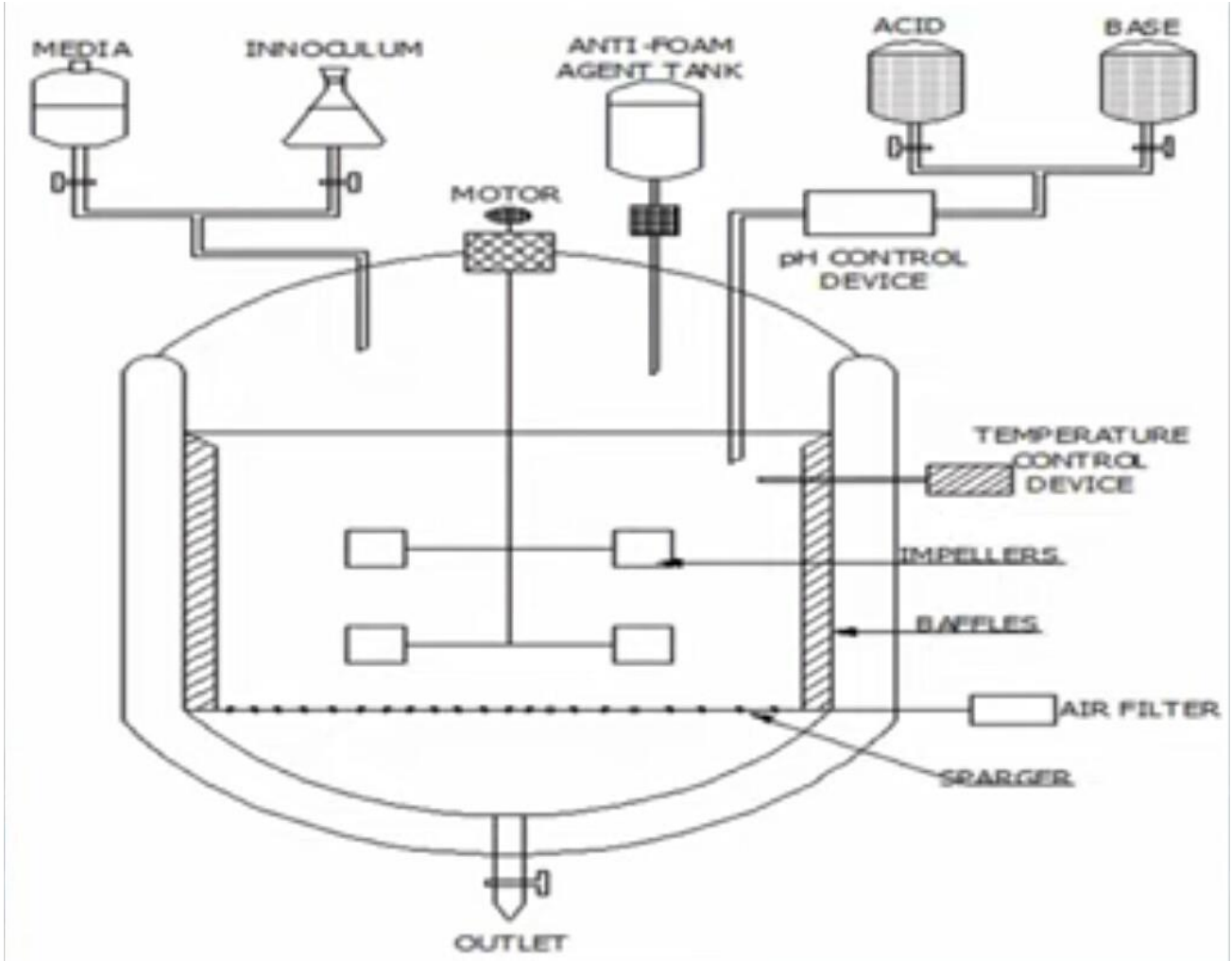
❖ Optimum conditions and desirable Fermentation Media are very important for obtaining high yield of product

Media of Fermentation Products

- The media is the feed solution,it must contain the essential nutrients needed for the microbe to grow.
- Factors of consideration when choosing media(**Quality consistance** dna **availability** era ereht erusnE&**no problems** rehto ro perP aideM htiw .sscorp noitcudorp fo stcepsa
- The quality of fermentation media is important for growth of microbes.
- Fermentation media provides **substrate for synthesis of product** ni .ssecorp noitatnemref
- The Yeild of the product is detrmined by the **types of nutrients** ni tneserp .aideM eht

Fermenter

- A fermenter can be defined as a vessel in which sterile nutrient media and pure culture of micro-organism are mixed and fermentation process is carried out under aseptic and optimum condition.
- Fermenter provides a sterile environment and optimum condition that are important for growth of micro-organism and synthesis of desired product.
- The success of production **high qualified product** no tnadneped ylhgih si .srotcaf latnemnorivne
- The fermenter needs to be able to control such factors as temperature , pH , and dissolved oxygen levels.


MEDIA
INNOCULUM
ANTI-FOAM AGENT TANK
ACID
BASE
MOTOR
pH CONTROL DEVICE
TEMPERATURE CONTROL DEVICE
IMPELLERS
BAFFLES
AIR FILTER
SPARGER
OUTLET

Development of Inocula for Fermentations

The inoculum is the **starter culture retnemref eht otni detcejni si taht

- It must be of sufficient size for optimal growth kinetics

**Since the production fermenter in industrial fermentation is so large, the inoculum volume has to be quite large

- A seed fermenter is usually required to produce the inoculum volume

- The purpose of seed fermenter is not to produce product but to prepare inoculum.

Problems Faced In Microbial Fermentation&Safety Of Fermentation Products

Major risk enhancing factors

-1Use of contaminated raw materials

-2Lack of pasteurization

-3Poorely controlled natural fermentations

-4Sub-optimal fermentation starters

-5Inadequate storage and maturation conditions

-6Consumption without prior cooking

-1Bacterial contamination:

This is the most common type of contamination in bacterial cultures.

Depending on the **type of bacterium** stceffe eht,ssecorp eht gnitanimatnoc .tnereffid era tuoba thguorb

In all cases,one may expect **reduced yield** elbissop dna,tcudorp fo .airetcab gnitanimatnoc fo setilobatem yb noitanimatnoc

In some cases **toxins**.stnanimatnoc yb decudorp eb yam

-1Bacterial contamination:

The probability of occurrence of a particular type of contaminations caused by bacteria may differ,depending on the **process** eht dna flesti **organism** ni desu .ssecorp eht

One of the most frequently occurring contaminants are lactic acid bacteria and sporulating bacteria.

Clean-up and re-occurrence prevention of especially the latter presents a considerable challenge.

-2Virus contamination:

- Viruses are the most **dangerous** noitatnemref eht ni tnanimatnoc eht era yeht,sezis llams ot euD.stcudorp**toughest enemy** tneverp ot gnitsal ,gnol yrev ni tluser yam ecnerrucco rieht dna,ssecorp eht gniretne .ytivitcudorp ytilicaf elohw fo sisylarap ,shtnom lareves neve
- A risk of producing fermentation products without optimal protection is something what can cost you a lot.

-3Fungal infection:

- Fungal cultures can be contaminated also by **other fungi** fo epyt siht sA . fo serusaem doog ,tceted ot drah ylevitaler eb yam noitanimatnoc **precuation**.ti tneverp ot nekatrednu eb dluohs

-4Dairy contamination:

- In dairy industry,contolling contamination issues is very important, not only due to possible health hazards.**Milk is a raw material** syawla tonnac hcihw, sniatnoc hctab yreve tsomla dna ,dezilirets eb**bacteriophages** ot suoitcefni .ssecorp noitudorp ni desu airetcab
- Moreover, some phages attacking lactic acid bacteria are resistant to pasteurization, and thus, they are much harder to eliminate. As it is not always possible to prevent bacteriophages from entering production process, there is a possibility to prevent re-infections, which are the ones to blame for vast majority of production failures.

Are fermented foods safer than fresh foods?

Cases of microbial food-borne infection have been reported in association with fresh cheese,sausages,fermented fish and fermented cereals.

Cases of microbial food intoxications due to mycotoxin contaminated raw material,production of microbial toxins,production of mycotoxins by fungal have been reported.

Toxic by-products(ethyl carbamate and biogenic amines)may be produced.

• Fermentation Media (Sterilization is very important(

**If not strilized:

Media can get contaminated

Lower yield of product

Inhibit Product synthesis

Alter Product

causing Economic Loss

Sterilization

- Sterilization is necessary for the complete destruction or removal of all microorganisms that could contaminate fermentation products and thereby constitute ahealth hazard.
- Different from preservation which its principle is(To hinder (delay) the growth of food spoilage microorganisms)
- Sterilizing the feed solution is essential because the media cannot contain foreign microbes because this could severely hinder the growth of the production microbe
- Most popular method is **heat sterilization**.noitulos deef eht fo
- Classical sterilization techniques using saturated steam under pressure or hot air are the most reliable and should be used whenever possible.

- **Types of Sterilization:**

1. Autoclaving 100° evoba)C)
2. Boiling 100°)C)
3. Passing Steam100°rewol)C)

• Sterilization Time is Different:

According to the type of fermentation media

−1Synthetic Media:

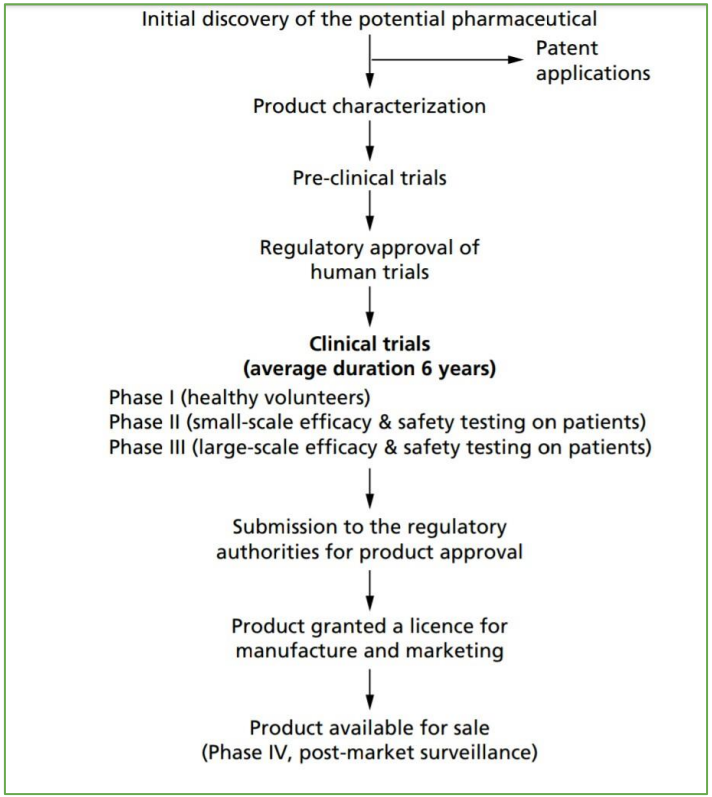
Exact composition of media is known,Sterilization is faster,Time required is less.

−2Crude Media:

Exact composition of media is unknown,Sterilization is slow,Time is more.

Fermentation Product Quality&Safety

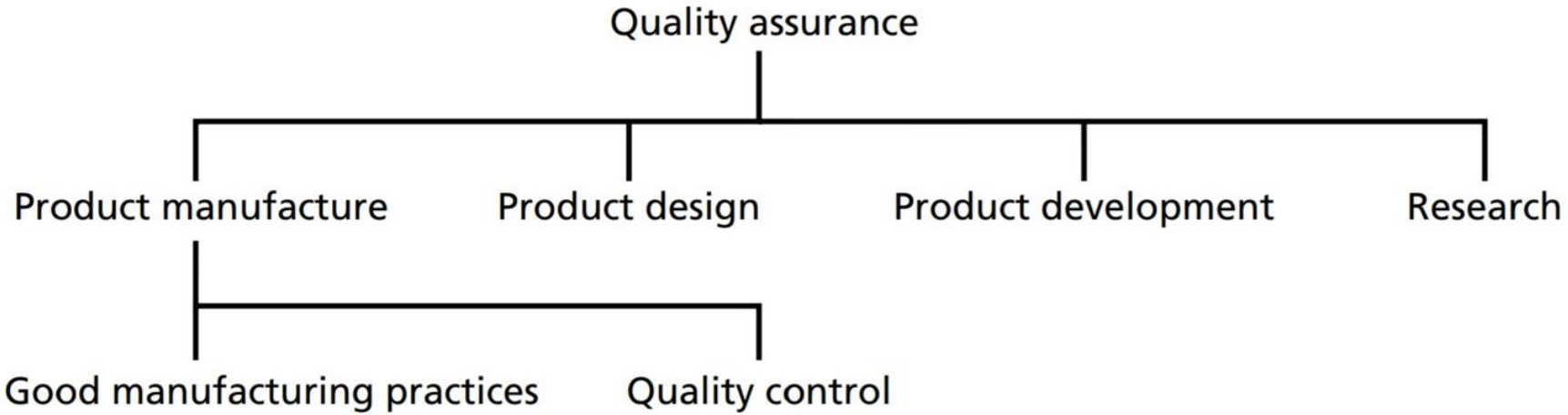
- Prior to approval for marketing, product that will used must be **tested**.
- Product licences granted after passing all requirements of the regulatory system.
- The necessary testing is lengthy and expensive, but is easier where the production organism has GRAS status (generally regarded as safe) .
- In case of pharmaceuticals, the process of manufacture validated and the product '**well characterized** sti fo noitanimaxe suorogir a sevlovni sihT .' **identity** ,(scitsiretcarahc lacimehconummi dna lacimehcocisyhp ,erutcurts) dna noitacfiitnedi eht dna,ytirup dna ycnetop fo noitacfiitnauq .seitirupmi eht fo noitacfiitnauq
- Pharmaceuticals must pass through three levels of trials prior to marketing and undergo postmarketing safety surveillance.



Development of Pharmaceutical Product

Quality Assurance (QA):

- Total of organized arrangements with the object of ensuring that products will be manufactured to a quality appropriate to their intended use.
- **Good manufacturing practices (GMP)** esoht,elpmaxe rof ,detpoda tsum SU eht yb deussi PMG) (ADF) noitartsinimdA gurD dna dooF SU yb desopmi eht fo noitarepo dna ,noitadilav,ngised no snoitalugeR laredeF fo edoC .(ytilicaf gnirutcafunam ygolonhcetoib/lacituecamrahp
- **Standard operating procedures (SOPs)** noitadilav riehT .deriuqer era eerged hgih a sedivorp taht ecnedive detnemucod gnihsilbatse sevlovni of assurance that a specific process will produce a product that meets predetermined specifications and quality attributes.



Components of quality assurance.

Manufacturing and environmental safety

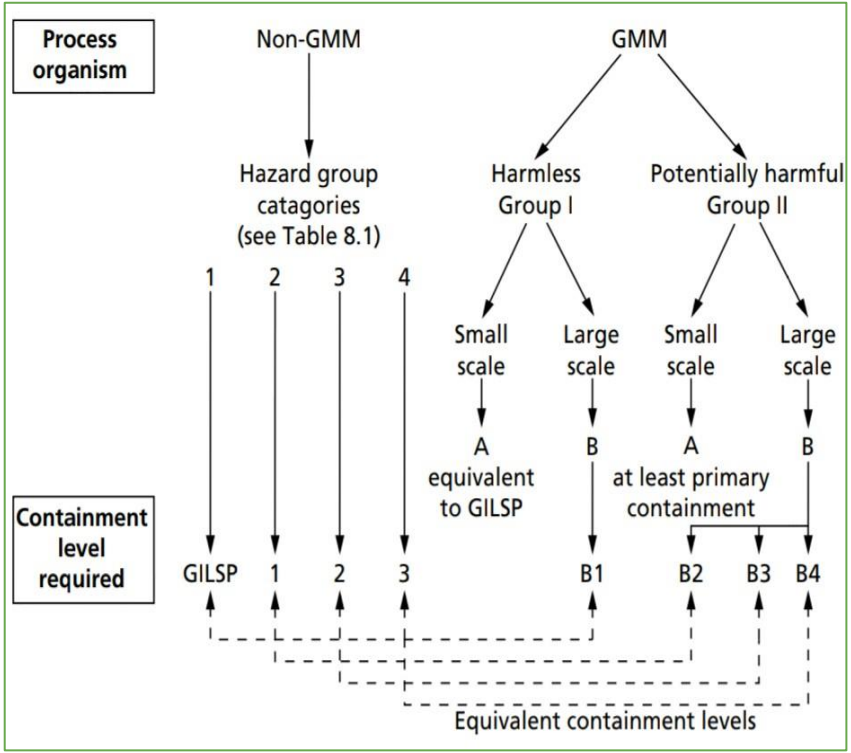
- Safety of employees in a manufacturing process is a primary concern.
- The population and the environment must be protected from the accidental release of potentially harmful microorganisms or microbial products.
- Safety within fermentation industries is important where known pathogens and certain GMMs are employed.
- The classification of microorganisms in terms of danger to humans divides them into four catagories, a division that is regularly updated by the regulatory authorities. These categories are similar for regulations formulated by UK, US and EU authorities, and by the World Health Organization (WHO).

	Containment required
Risk group 1 Low individual and community risk. A microorganism that is unlikely to cause human disease or animal disease of veterinary importance	Good industrial large-scale practices (GILSP)
Risk group 2 Moderate individual risk, limited community risk. A pathogen that can cause human disease or animal disease, but is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposures may cause serious infection, but effective treatment and preventive measures are available and the risk of spread is limited, e.g. *Salmonella* food poisoning. Vaccines and antibiotics are available	Level 1 containment
Risk group 3 High individual risk, low community risk. A pathogen that usually causes serious human disease, but does not ordinarily spread from one infected individual to another. Prophylaxis and treatment may be available	Level 2 containment
Risk group 4 High individual and community risk. A pathogen that usually causes serious human or animal disease and may be readily transmitted from one individual to another. No effective prophylaxis or treatment is available, e.g. Ebola virus	Level 3 containment

World Health Organization classification of microorganisms on the basis of hazard

Cultivation of microorganisms:

- Categories of process microorganisms and the level of containment required when used at research and industrial sites within the European Federation of Biotechnology
-)GILSP = good industrial large-scale practice ;
- GMM = genetically manipulated microorganism.(




If you can
DREAM IT
you can do it