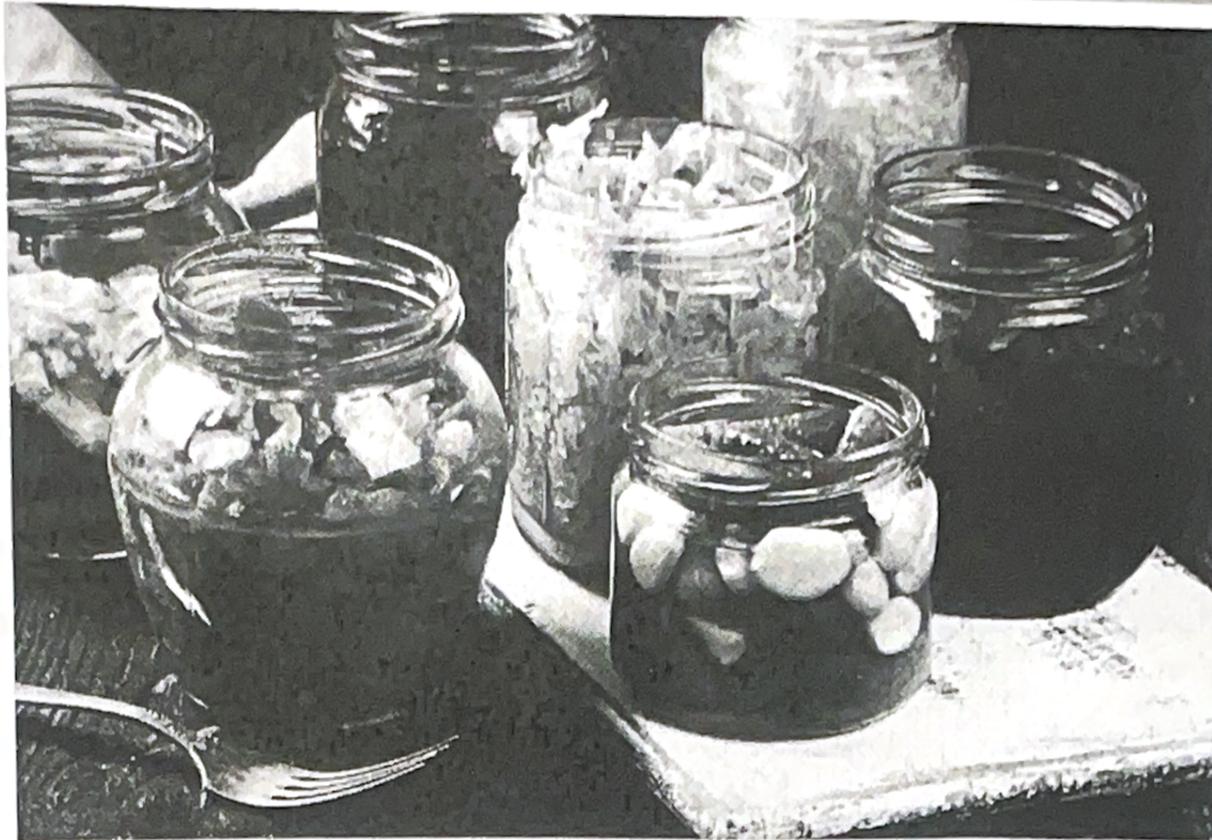


People Around The World Use Fermentation
To Preserve And Add Flavor To Foods



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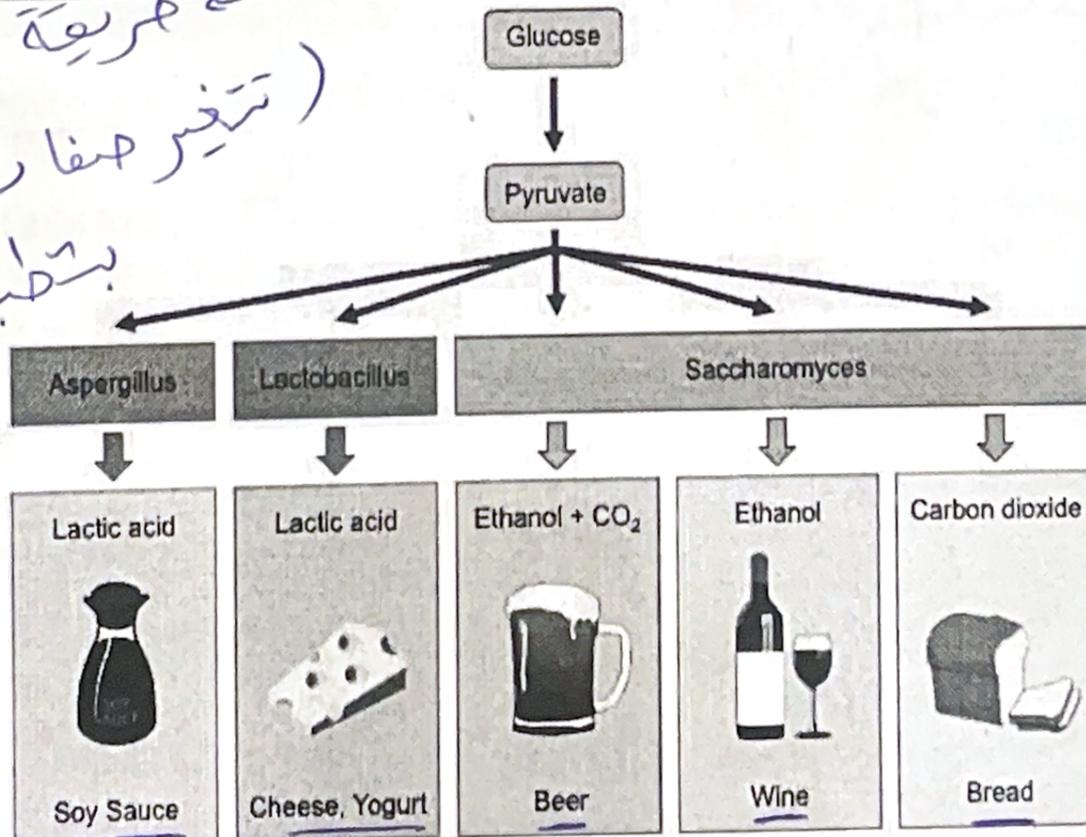
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Introduction To Fermentation



طريقة طبخ بدون حرارة
(تغيير صفات الطعام بآلية
بتطبيقه)



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Introduction To Fermentation

لانه بي احصل على المنتج بكميات كبيرة بي كمية كبيرة وكافية من MO

- The science of Fermentation is called ZYMOLOGY.
- Fermentation means any process that converts larger molecules into smaller and simpler molecules using micro-organisms i.e. it is a metabolic anaerobic process that converts Sugars (larger molecules) to acids, gases, alcohol or any metabolic by-product.
- Thus in biotechnology Fermentation is a process in which micro-organisms are grown in large quantiles by providing them favourable conditions which converts Organic complex substances to simpler compounds.
- Fermentation also occur in oxygen starved muscle cells, as in case of Lactic acid . Fermentation.
- Two common types of fermentation are named for their end products, alcoholic fermentation and lactic acid fermentation.

aerobic ↗ fermentation ←
anaerobic ↘

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هو النوع الشهير لانه هو بي
بصير داخل الخلايا

WHAT DOES IT LOOK LIKE TO COOK WITHOUT HEAT?



فلاننا بكم لازم تتفهم ويطالب وجود O2

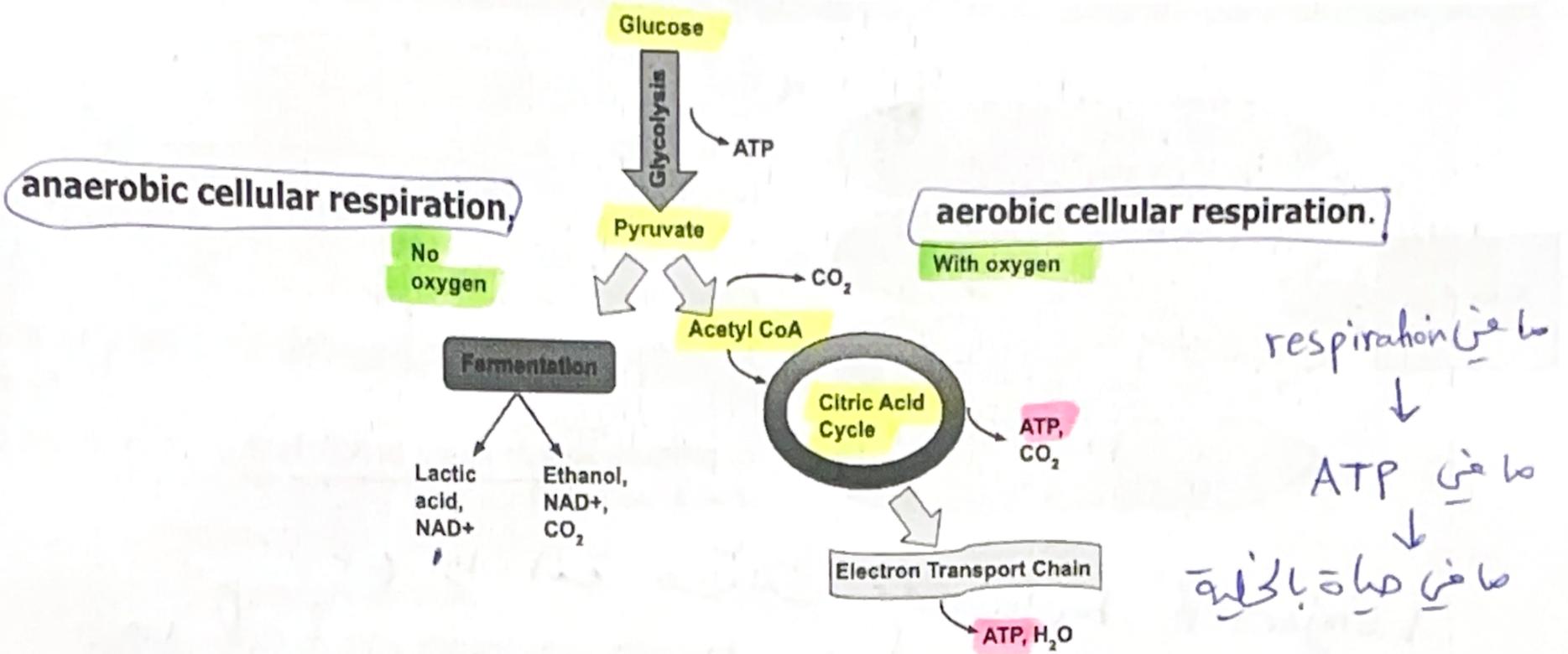
- microbes (even single-celled bacteria) use cellular respiration also called aerobic respiration, to produce chemical energy called ATP.
- Cells get that energy by breaking down glucose (a simple sugar) through a cycle of biochemical reactions. For that energy-producing cycle to work, they need oxygen. Cells need a constant stream of energy to survive. Even a few minutes without it can be fatal. In fact, the deadliness of many poisons is linked to their ability to disrupt the process of cellular respiration.
- When oxygen is plentiful, a microbe makes energy with that key ingredient using aerobic respiration.
- But when there is no oxygen left in the pantry (or the environment), cells can still make energy. One way they do this is with fermentation, which is a kind of anaerobic respiration. Though not nearly as efficient as aerobic respiration, fermentation enables a cell to survive until oxygen is plentiful again. It also produces byproducts such as lactic acid and carbon dioxide.



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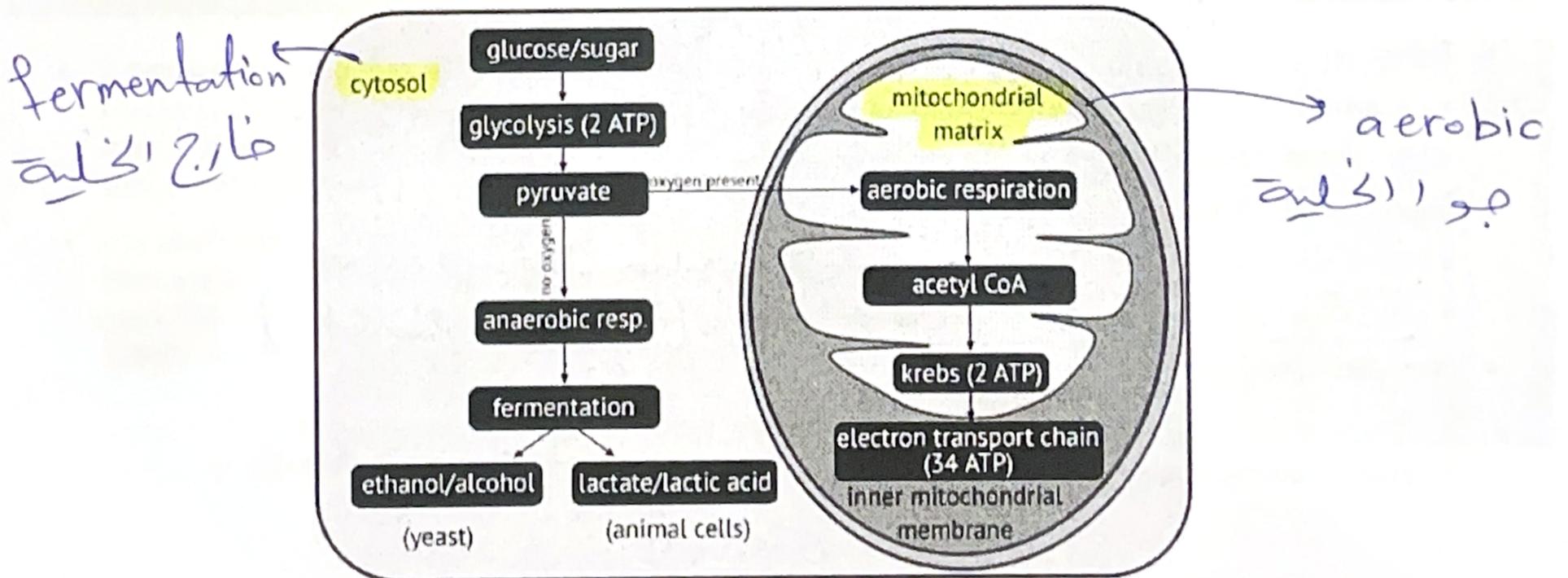
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Cellular respiration and fermentation phases

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← في حالات الإجهاد أو stress مستوى O_2 يكون قليل تفضل الخلية
سواءً توقفت تنفس في لا ، تحاول تدفن طريقة ثانية من fermentation
(break down glucose to produce ATP)
(but efficacy of ATP production from fermentation
less than aerobic cellular
respiration)

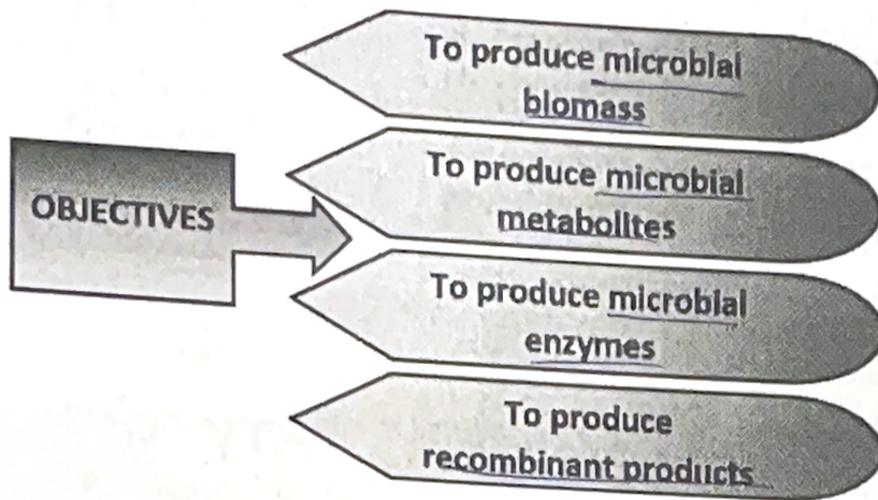


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OBJECTIVES OF FERMENTATION



The major objectives of fermentation are:

1. To produce large amount of microbial cells or **Biomass** (Large microbial colonies).
2. To produce microbial metabolites (e.g- microbial metabolite of Glucose are Lactic acid, Ethanol etc).
3. To produce microbial enzymes (e.g- proteases, invertase etc).
4. To produce recombinant products (e.g- productions of several vaccines).

كمية كبيرة من الخلايا
كإنزيماتها
كثبات صويّة

لأنّ إذا أنتجنا بكتيريا bioinjected bacteria
in which gene of insulin is incorporated in
genetic material of the bacteria

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growth let's see fermentation
عن الانسولين (بتعريف البكتيريا بصبغ insulin recombinant)
(recombinant insulin)

Introduction To Fermentation



Types:

- Anaerobic (absence of oxygen) – e.g., ethanol production.
- Aerobic (presence of oxygen) – e.g., antibiotic production.

Importance in Pharma:

- Sustainable production of drugs. → + clean → by product
- Cost-effective methods for large-scale synthesis.

Examples in Pharma:

- Penicillin from *Penicillium* fungi.
- Insulin production using genetically engineered *E. coli*

(بأنّ ننتجها غير ضارة + موكمية كبيرة)

Microorganisms (MOs) In Fermentation



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(قرأتها مرة أخرى)

Common Organisms:

- Bacteria (e.g., Escherichia coli for insulin).
 - Fungi
 - e.g., *Penicillium chrysogenum* for penicillin.
 - *Aspergillus niger* for citric acid production
 - Yeasts (e.g., *Saccharomyces cerevisiae* for recombinant vaccines).
 - *Aspergillus niger* for citric acid production
- ## Selection criteria:
- High productivity (High yield of product).
 - Stability and ease of cultivation.
 - Easy genetic manipulation (ability to be engineered)

→ can be easily bioengineered

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Definition Of Fermentor

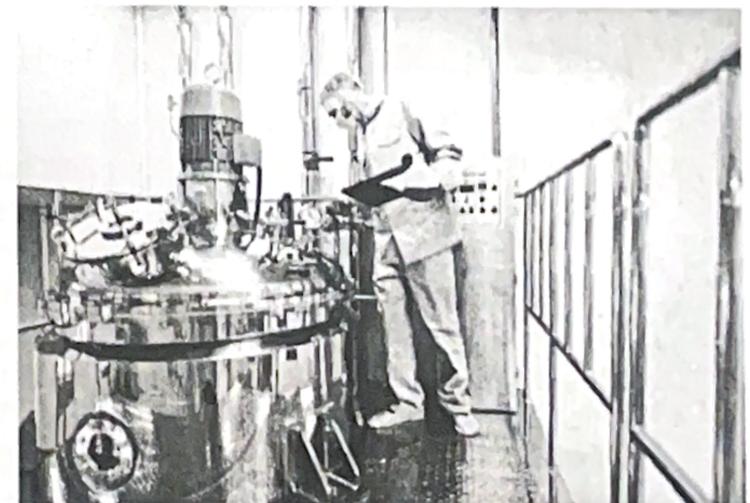


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(قرأتها مرة أخرى)

- A Fermentor can define as a closed cylindrical vessel which supports the biochemical and chemical activity of the microorganisms to carry the conversion of raw material into some useful product.
- It is also called a bioreactor, as it makes the use of microbial biomass to accomplish the fermentation process. Depending upon the use of stock culture, a fermentation process is subdivided into surface and submersion techniques. In surface fermentation, the biomass is cultivated on the surface of the raw substrate, while the microorganisms grow in the raw substrate during submersion fermentation.



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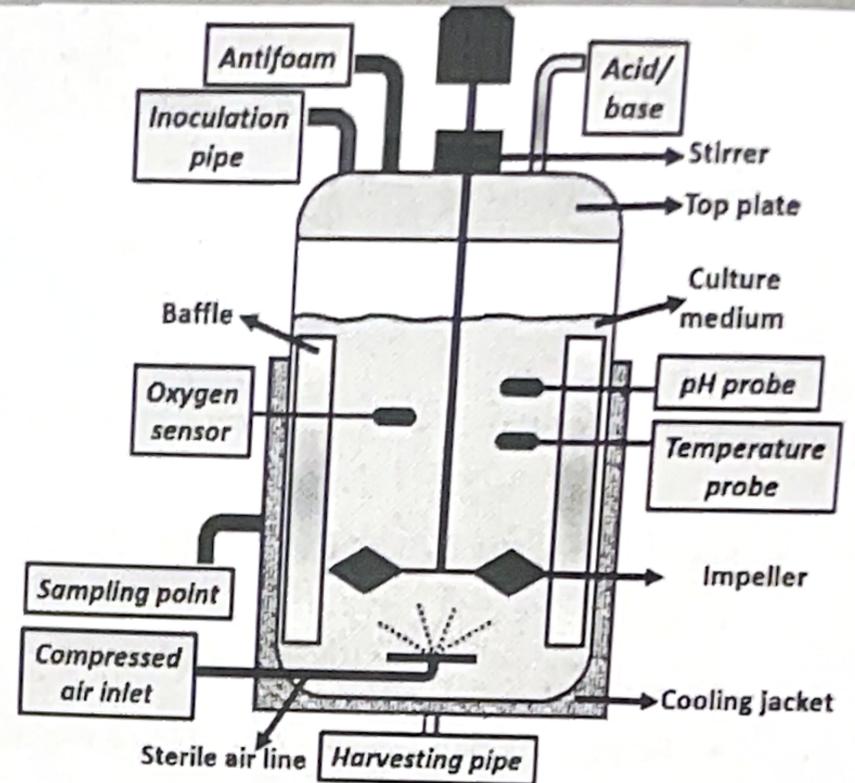
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Fermentor



- The construction of fermentor includes the following components:
- Basic elements
- Controlling elements



Design of a fermentor

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ما هو

Fermentor



- Basic components are necessary for the construction of fermentor, which involves:
- **Top-plate:** It is the cover that is generally made of stainless steel.
- **Inoculation pipe:** It helps to port the inoculum inside the fermentor.
- **Drive motor:** It drives the impeller shaft.
- **Impeller shaft:** Holds the agitator centrally.
- **Impeller:** Acts as an agitating device for mixing up the nutrients and microorganisms uniformly.
- **Stirrer:** Mixes the gas bubbles throughout the liquid culture medium.
- **Baffle:** Prevents the counterflow or vortex formation by breaking down the gas bubbles to improve aeration efficiency.
- **Sparger:** It supplies oxygen into the culture medium through the perforated tubes.
- **Drain point:** Withdraws cells or medium for the continuous fermentation.
- **Cooling jacket:** It is fitted externally to the fermentation vessel which allows the passage of steam or cold water to balance the heat generated during the process.

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CONTROLLING ELEMENTS



- Controlling elements monitor the parameters like (temperature, pH, acid, bases, oxygen supply, pressure etc.) that are necessary for the product formation and it includes:
 - Foam probe: It senses foam formation.
 - pH electrode: Monitors the pH in the culture vessel.
 - Oxygen sensor: Maintains the dissolved oxygen content level.
 - Heating pad: Provides heat to the medium.

لازم يعقموك في الأول عشان تضمن انه
عمل بيتر فقط من (one M.O) بيتر بيتر
Fermentation
س

Ideal Properties Of A Fermentor



- A fermentor should be made of a good quality material that can withstand all the conditions inside the vessel.
- It should give high productivity.
- It should be able to handle the stream (sterilization) pressure.
- There should be all the control parameters to monitor the fermentation process like pH electrode, temperature probe etc.
- A material used in the fermentor should be cheap that could give satisfactory results.

يكون مصنع بطريقة تسمح لا operator
يراقب ويتحكم بجهول parameter

← لما بدك تجيب fermentor لازم تكون متأكد من الخصائص تاعته
* المواد المستخدمة في تصنيعه لازم تكون مناسبة
(in direct contact with the reaction mix)

يتحلل الفروني بيتر ممكن تغير مثل تغير في الحرارة أو في pH
وكان يكون compatible لأنه بيتر M.O ممكن تتغذى عن المواد
المصنوع منها with M.O

The General Requirements For Fermentation Process



- 1. Fermentation medium
- 2. Inoculum
- 3. Fermenter
- 4. Sterilisation
- 5. Growth of organism
- 6. Extraction and purification

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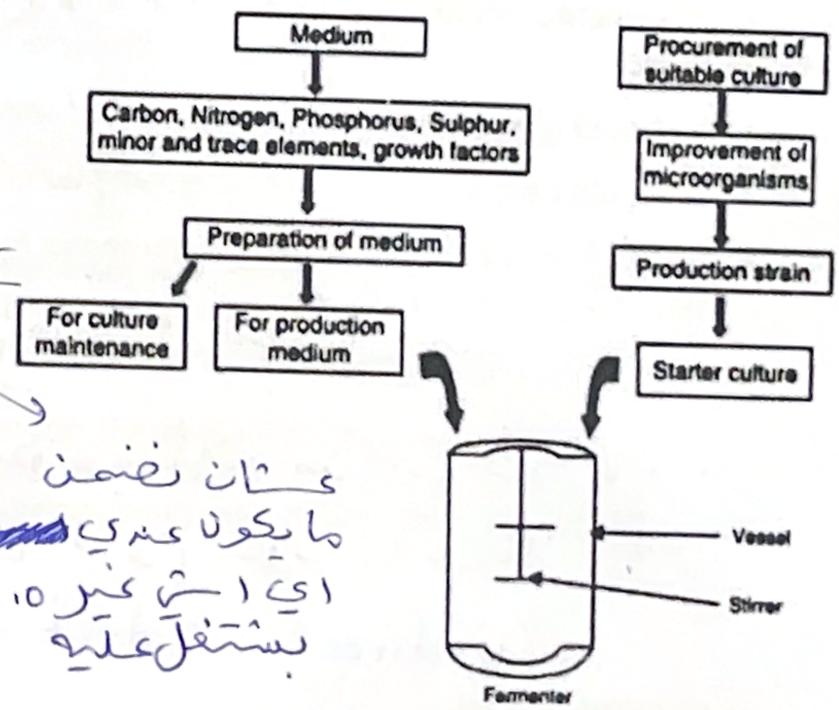
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① تحضير *in media* لاسببة لـ M.O ، بغيره M.O ممكن
 يحتاج مكان نمو يكون (adherence to surface)
 و بغيره يكون *suspended in a media* ، بالغالِب fermentation يكون *suspended*

Basic Steps Of Fermentation Process And General Requirements



- The basic steps for fermentation process are:
- 1. Formulation of fermentation media: it is chemically a cell culture media which is a mixture of molecules used for cellular metabolism and growth. e.g. Carbon source, energy source, oxygen, nitrogen etc.
- 2. Sterilisation: sterilisation of fermentation media, Fermenter and other equipments. (عمل اسي)
- 3. Inoculum formation: production of an active, pure culture In sufficient quantity to inoculate into the production vessel. بجزوه على جنب
- 4. Fermentation: growth of the micro-organism in the production fermenter under optimum conditions for formation of by-products. بعديت بعينه
- 5. Extraction and purification of the product.



مكان رضمن
 ما يكون عندي
 اي اسي كثير M.O
 يستعمل عليه

Fig. 20.4: Steps of up-stream process (USP).

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vessel reaction mixture
 by product, M.O, media
 ميو كيترا ميا

Fermentation Stages



- Two main steps/stages
 - ① - Up-stream process
 - ② - Downstream process
- Upstream process comprises of obtaining a desired microorganism, and its improvement so as to enhance the productivity and yield. It also includes the maintenance of strain purity, preparation of inocula and further efforts to improve the economic efficiency of the process.

Fermentation Stages



- Downstream process includes the selection of suitable fermentation media, optimization of important fermentation condition to give rise maximum yield and recovery.

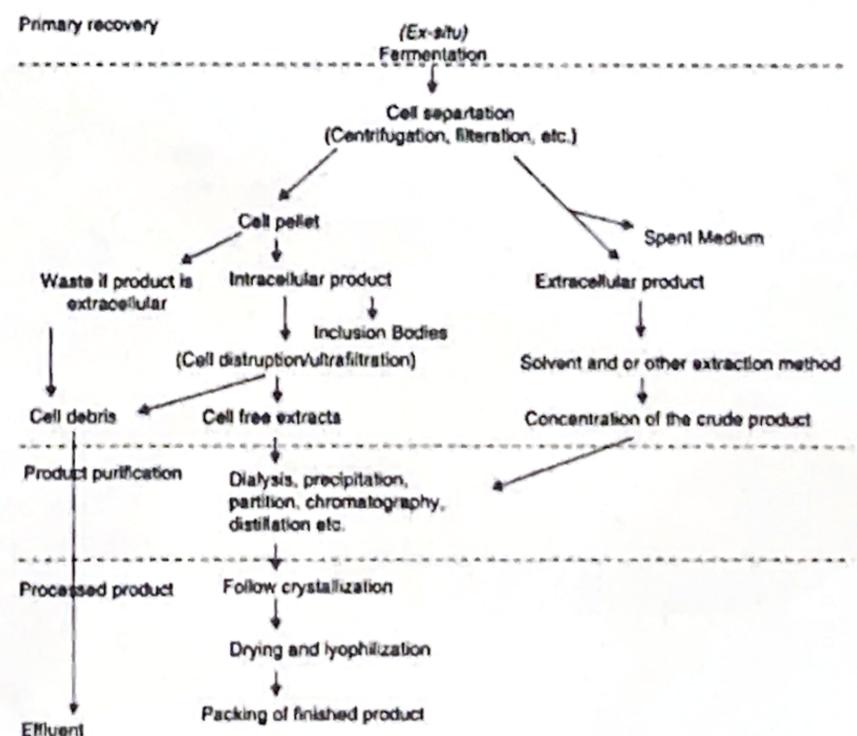


Fig. 20.5: Steps of down-stream process (DSP).

Up-stream Vs. Downstream Process



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Aspect	Upstream Process	Downstream Process
Focus	<u>Cultivation and production</u>	<u>Recovery and purification</u> of the product المرحلة الأخيرة
Stages	<u>Bioreactor setup, cell growth, and metabolism</u>	<u>Harvesting, purification, and formulation</u>
Equipment	<u>Bioreactors, fermenters</u>	<u>Filtration units, centrifuges, chromatography systems</u>
Output	<u>Crude biological mixture</u>	<u>Pure, usable product</u>

المرحلة الأخيرة
التخلص من
extraction
and purification