Fermentation

The main components of the fermentation process:

Whatever the type of fermentation (with the possibility of excluding some conversion processes), any fermentation process can be **divided into six basic component parts:**

1) Preparing or formulating the Medium, which will be used in the development of the vaccine and in the production fermenter. A food item requires its ability to enter the cell, and that the cellular system be able to use it, both of which depend on the type of protoplasmic contents in the cell.تهيئة اوتحضير الوسط الغذائي الذي سيستعمل في تنمية اللقاح وفي مخمر الإنتاج

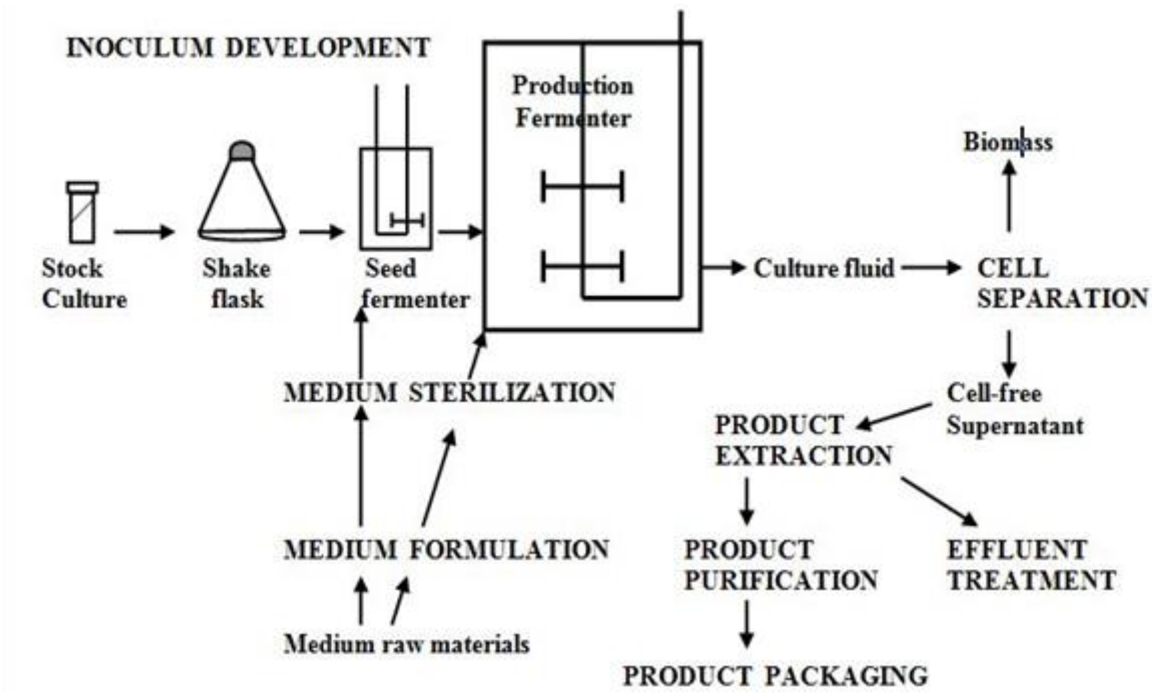
2) Medium Sterilization, fermenter and ancillary equipment. A sterile environment means that it is free of living organisms, while sterile fermentation means using an environment that contains only the desired organism (which performs the fermentation process). Sterilization is carried out by **physical methods** that include: heat, filtration, radiation, and others. **Chemical methods** include the **use of acids**, alkalis, alcohols, phenol and its compounds, Phenol, and other substances. ويقصد بالبيئة المعقمة خلوها من الكائنات الحية، في حين ان التخمر المعقم يعني استخدام بيئة تحتوي على الكائن الحي المرغوب فقط

3) Production of Pure and active culture, in sufficient quantity to pollinate the production vessel. إنتاج مزرعة نقية ، نشطة بكمية كافية لتلقيح وعاء التخمر

Contamination may occur during the production of the vaccine (or starter) but is not distinctive, or the contamination may be large and easily noticeable. Therefore, all attempts should be made to detect the level of contamination so that the pollen production ponds are completely free of contamination.

4) The development of the organism in the Production Fermenter under optimal conditions for the formation of the desired product, including the biological, physical and chemical environment.

5) Extraction and Purification: After the fermentation process is completed, it is the turn to obtain the resulting materials in a pure and acceptable form, and these processes are called **Down Streaming** التدفق للاسفل. This stage must be completed as soon as possible in order to avoid any change or damage to the product. ويجب ان تتم هذه المرحلة بأسرع وقت ممكن تلافيا لحدوث أي تغير أو تلف للمنتوج.



The selection of the extraction method depends on the type of fermentation and the type of equipment available. The factors that play a role in choosing the method can be summarized as follows:

1. Concentrate the product in a liquid fermentation medium.

2. The chemical and physical specifications of the required product are important to determine the method of separating it from the culture media.

3. The purpose of using the fermentation product.

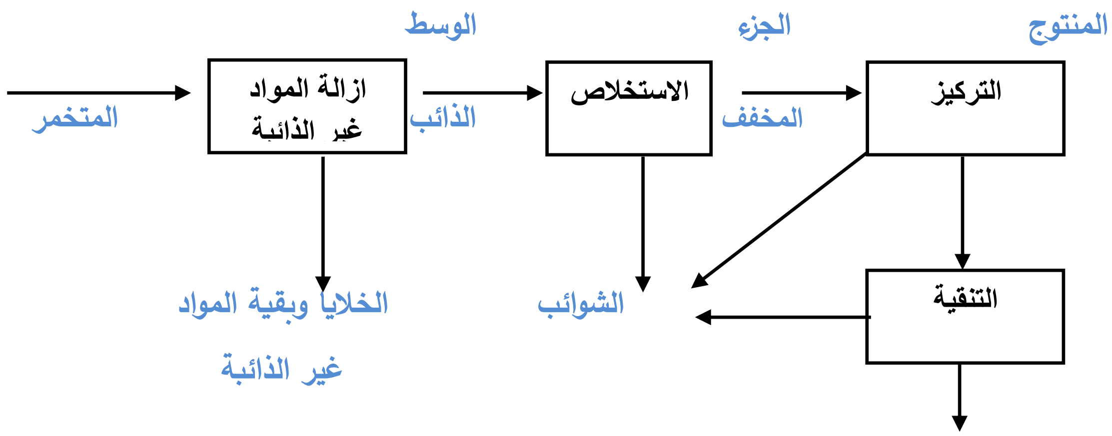
4. The presence of the product inside or outside the cell.

5. The percentage of impurities الشوائب in the culture medium for the fermentation process.

6. Knowledge of the percentage of impurities in the product that are acceptable in standardization and control.

7. The product's economic value (market price).

The following diagram shows a summary of the process of extraction and purification of an extracellular product: ويوضح المخطط التالي ملخص لعملية استخلاص وتنقية منتوج ذائب في الوسط الزرعي خارج الخلاياExtracellular:



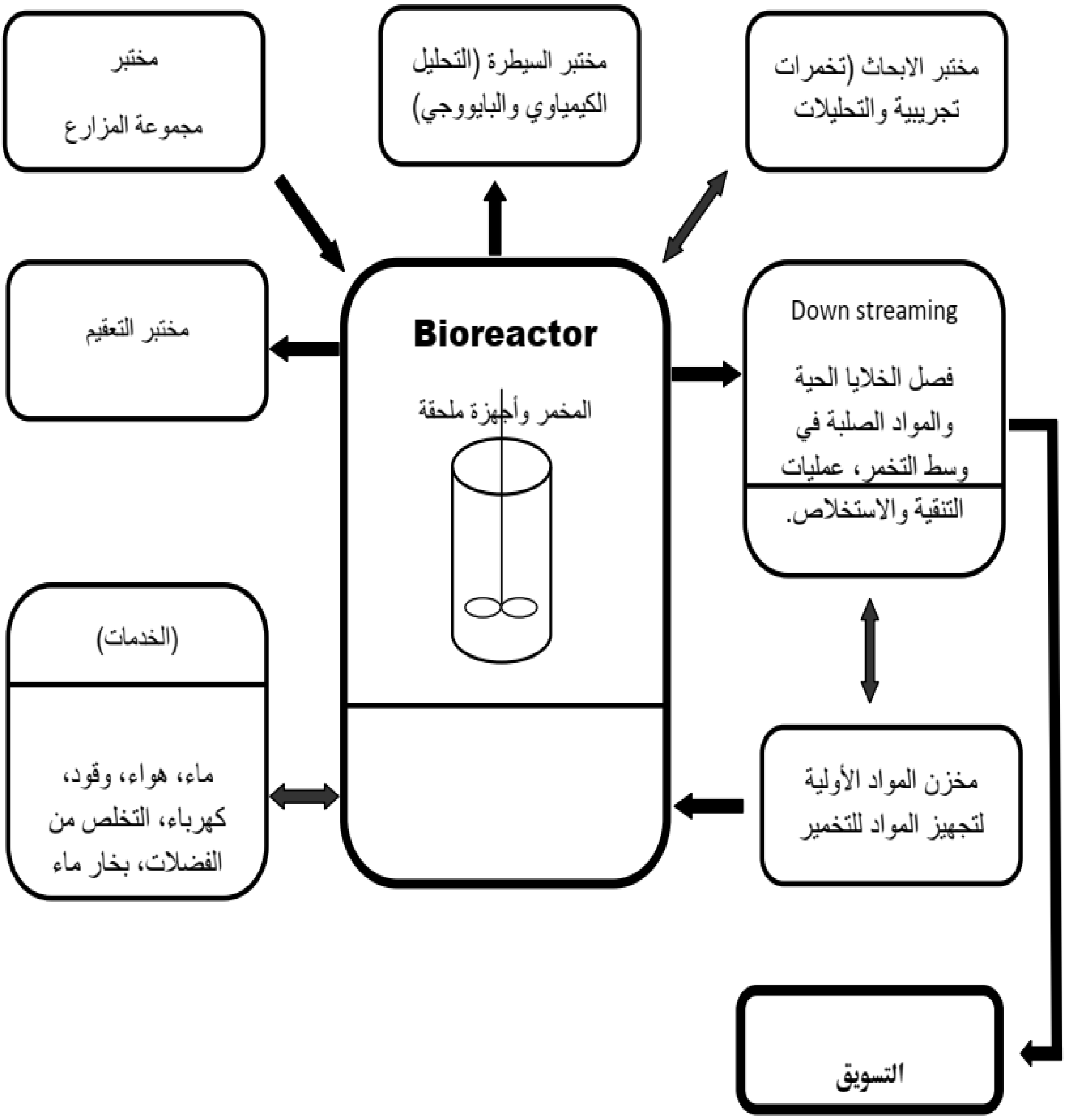
(مخطط عام لاستخلاص منتجات التخمر الذائبة خارج الخلايا)

6) Elimination of effluents resulting from the fermentation process: التخلص من السوائل الدافقة الناتجة عن عملية التخمر Most industrial processes result in watery waste containing varying amounts of salts and organic materials. Residues associated with fermentation industries include spent environments, wash water, and water collected in the different steps of the product recovery process. As well as accumulate organic solvents during the recovery of industrial fermentation products.

Fermentation Unit :وحدة التخمير

Essential Features of a Fermentation Unit :المقومات الأساسية لوحدة التخمير

The fermentation unit in industrial fermentation is similar to the chemical plant in the chemical industry. The existence of differences is due to the needs of the life process of sterilization and to ensure the functioning of its enzymatic reactions compared to chemical reactions and their cofactors, which sometimes take place at high temperatures and pressures. In general, the design principles are applicable regardless of the scale of the fermentation process. The following figure shows a general schematic diagram of the fermentation unit:



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Bioreactor Design: تصميم المفاعل الحيوي

Bioreactor: A vessel for culturing microbes and growing cells or for carrying out chemical reactions used in biotechnology applications. A bioreactor is a system for containing the biological reactions of biotechnology processes. It provides the right environment to control the growth of organisms and metabolic activity, it must prevent the contamination of the production farm from the environment and also prevent the release of the production farm into the environment, and it must contain the required machinery or sensors that allow optimal control of the process. المفاعل الحيوي: هو وعاء لزراعة الميكروبات و تنمية الخلايا او لأجراء التفاعلات الكيميائية المستخدمة في تطبيقات التقنية الحيوية. المفاعل الحيوي هو نظام لاحتواء التفاعلات البيولوجية لعمليات التقنية الحيوية. حيث يوفر البيئة الصحيحة لتضبيط نمو الكائنات والفعالية الأيضية، ويجب ان يمنع تلوث مزرعة الانتاج من البيئة وايضا منع انطلاق مزرعة الانتاج الى البيئة، ويجب ان يحتوي على الآلات المطلوبة او المجسات التي تسمح بالسيطرة المثلى على العملية.

Research laboratories typically use small bioreactors with a capacity of less than one liter of medium. As for laboratories that work on developing new biotechnology products, they use medium-sized bioreactors that have the ability to absorb several liters of medium. These are usually used in wide applications called pilot plants, which is a series of experimental operations that investigate the possibility of carrying out certain biological technologies in large quantities and in an economically efficient manner. Biotechnology companies that produce large volumes of materials use bioreactors with a capacity of thousands of liters.

A closed bioreactor used in cellulosic ethanol research

Autoclavable bench-top laboratory bioreactor

used for fermentation and cell cultures

Dr.Lina Abdulameer Salman

Some bioreactors are called **fermenters** because they carry out the processes designed for them in the absence of oxygen. They are suitable for some organisms that perform a type of metabolism in the absence of oxygen, which is **called fermentation**. Alcohol and many biotech products are made using fermentation. As well as there are certain chemical reactions inhibited by the presence of oxygen also take place under the conditions of fermentation. Some bioreactors, also referred to as **bioprocessors** المعالجة الحيوية and **digesters** الهاضم, are used to produce a variety of chemicals from secretions produced from cell cultures.

Where drug production companies use bioprocessors to produce insulin from genetically modified bacteria. Digesters contain cells or chemical mixtures that break down certain compounds, turning them into economical products. Biofuels (fuels derived directly from living matter) such as methane are produced using a digester. Where bacteria and yeasts growing in a special digester break agricultural waste from plants or animals into biofuels.

حيث تستخدم شركات انتاج العقاقير **المعالج الحيوية bioprocessors** في انتاجها الانسولين من البكتريا المحورة وراثيا. المفاعلات الحيوية **الهاضمة digesters** تحتوي الخلايا او المخاليط الكيميائية التي تكسر مركبات معينة محولة اياها الى منتجات اقتصادية. **الوقود الحيوي Biofuels** (الوقود المشتق مباشرة من المادة الحية) مثل غاز الميثان ينتج باستخدام **الهاضم**. حيث تقوم البكتريا و الخمائر النامية في هاضم خاص بتكسير المخلفات الزراعية من النبات او الحيوان الى الوقود الحيوي.

There is no specific format for the bioreactor. Its design and function depend on the type of reaction carried out and the type of materials to be produced. However, bioreactors have **several basic components**: atmosphere supply, product collection port, control panel لوحات تحكم, media supply, mixer, and vessel. Bioreactors can be produced in various shapes and sizes used for a variety of purposes.

The vessel is the main component in a bioreactor, and it can be made of ceramic, glass, metal, plastic or composite resin materials يعد الوعاء المكون الرئيس في المفاعل الحيوي، ويمكن ان يصنع من السيراميك ، الزجاج، المعدن، البلاستك او مواد راتنجية مركبة (Vessels can be made of ceramic, glass, metal, plastic, or a composite resin material). Materials such as ceramics, glass, and plastic usually do not harm or interfere with cells and chemical reactions. However, they are fragile materials that quickly break down, so their use is limited to small bioreactors.

Larger bioreactors must be made of strong materials such as metal, but most cells and vital reactions are inhibited by metals, so metal bioreactors are made of stainless steel الفولاذ المقاوم للصدأ because it does not corrode or rust when damaged, and because corrosion and rust leak metals into the contents of the bioreactor. Other metal bioreactors are lined with ceramic or glass to provide a safe and easy condition in the vessel. Bioreactors of composite resin materials are usually made of glass fibers fixed with a resinous plastic that does not harm or interfere with cells and chemical reactions.

One of the essential aspects of fermentation is that the vessel is maintained to be a clean and safe environment, and this is accomplished through strict methods of sterilizing and decontaminating the reaction vessel. Sterilization includes removing or destroying all microorganisms that can damage the biological process, while decontamination includes removing harmful chemicals that interfere with the biological process. The safe environment inside the bioreactor vessel is the function of the rest of the reactor components.

The continuous movement الحركة المستمرة of the liquid inside the bioreactor is an essential factor for keeping cells or chemicals inside the vessel and preventing them from settling to the bottom. In general, fermentation industries require bioreactors that can meet the requirements of various operating conditions, including varying viscosities, aeration rates, agitation intensity and volume of fermentation.

In practical application, **continuous stirred tank reactors (CSTR)** مفاعلات خزان المزج المستمر have become widely accepted. The basic design of the perpetual-shake reactor (CSTR) was developed during the 1940's to 1960's with the industrial **production of penicillin**. Observed in the following picture a common model of industrial bioreactor type CSTR:-

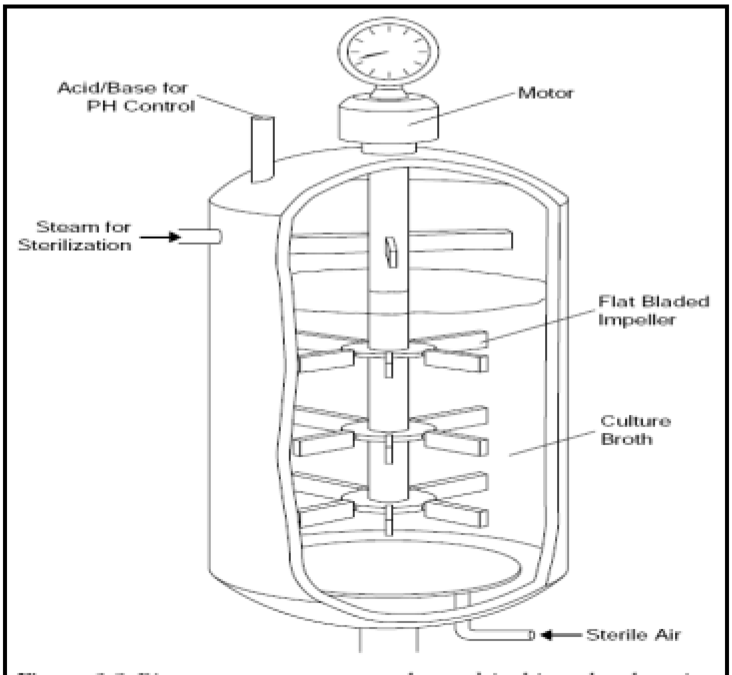

Figure 3.2 Bioreactors are commonly used in biotechnology industries to produce commercial chemicals, food ingredients, and drugs. They are designed to keep cells and microorganisms alive and reproducing. (*Jeff Dixon*)

Types of bioreactors:

There are 6 types of bioreactors used in bioprocess technology are:

1- Continuous Stirred Tank Bioreactors مفاعلات خزان المزج المستمر

2- Bubble Column Bioreactors مفاعلات الفقاعات العمودية

3- Airlift Bioreactors مفاعلات المزج بالهواء

4- Fluidized Bed Bioreactors المفاعلات الحيوية ذات الحبيبات في السائل

5- Packed Bed Bioreactors المفاعلات الحيوية ذات الحبيبات المعبئة

6- Photo-Bioreactors المفاعلات الحيوية الضوئية

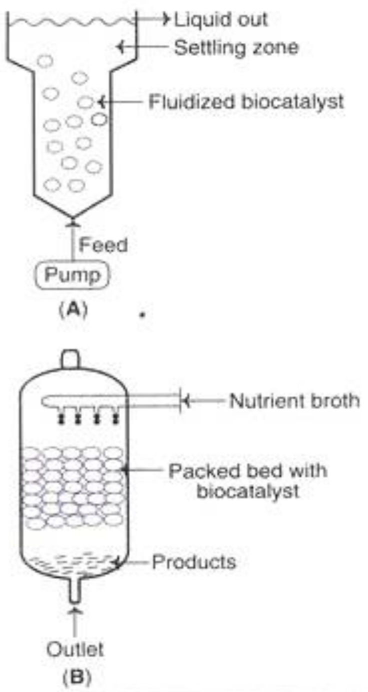

Fig. 19.3 : Types of bioreactors (A) Fluidized bed bioreactor (B) Packed bed bioreactor.

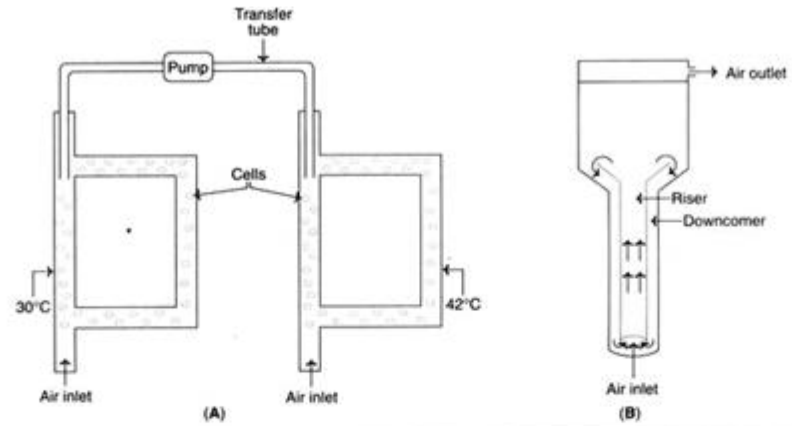

Fig. 19.2 : Types of bioreactors (A) Two-stage airlift bioreactor (B) Tower bioreactor.

Double or Multiple Fermentation :التخمرات المزدوجة أو المتعددة

They are those fermentations in which more than one microorganism is used, as the organisms are vaccinated simultaneously in the growth environment, or that one organism may grow first in the environment, followed by the pollination and growth of the second microorganism. Alternatively, after growth has occurred in the original environments, two separate fermentations can be combined together to complete the additional activity. The basic idea in these ferments is that two or more microorganisms accomplish something that a microorganism alone cannot. There are many important uses for double or multiple fermentation, including:

1- The use of a single microorganism to produce a fermentation product that is then transformed or changed by another microorganism or several microorganisms into different fermentation products of greater economic value. An example is vinegar production, in which yeast produces ethyl alcohol first and then Acetobacter species convert the alcohol into vinegar.
2- The use of one microorganism to change or create an environment that is more suitable for the growth of another microorganism. For example, a microorganism may achieve amylase or protease activity for a second microorganism that lacks these activities.
3- The use of a microorganism to remove toxic metabolic byproducts of another microorganism, a microorganism that prepares the growth factors of another organism, or another microorganism to remove oxygen or to reduce the redox potential of an anaerobic microorganism, or a microorganism to maintain a range of The pH is critical for another organism.
4- The use of a microorganism to give a metabolic product such as lactic acid, which is beneficial for the growth of a second microorganism such as yeast, and at the same time helps in controlling contamination.