PHARMACEUTICAL BOTANY

Pharmaceutical Botany is a branch of science that examines plants that are used directly as drugs or used for the production of drugs.

When performing this examination, it places outmost importance to indicate;

- the position of plants within plant systematics,
- special structures of plants,
- parts of plants used in the production of drugs (drog),
- primary active substances that are responsible for their utility,
- effects of both these substances and the drogs.

Physicians continued to treat their patients with mostly botanical natural drugs for years.

When the fact that diagnosing a disease and preparing the drug requires different specialization was clearly understood, medicine and pharmacy was divided into two professions and continued their development in their own fields of expertise.

The continuing increase in the number of plants used for the purpose of treatment led to the development of a separate art that would deal with these plants (i.e. Pharmaceutical Botany).

Pharmaceutical Botany could only become an independent art in the 19th century.

- Deals with plants yielding medicines;
- Is a science that covers;
- the location of these plants within plant systematics,
- their special structures,
- the drugs that they yield active substances that these drugs contain, and
- their indications.

It also examines plants that are used as
- spices,
-dyes,
- foods, and also
- poisonous plants

Pharmaceutical Botany has also become an important science in Turkey during the same century. In 1839, a class of Pharmacy has been opened in Galatasaray Medical School as a specialty science of the profession and the course Pharmacuetical Botany was introduced to the pharmacy education and has been taught continuously ever since.

The School of Pharmacy became a part of İstanbul University Faculty of Medicine in 1944 and the courses were continued with the same context under the name "Pharmaceutical Botany". School of Pharmacy became İstanbul University Faculty of Pharmacy in 1962, and after that Pharmaceutical Botany has been accepted as an independent department in this faculty. The first pharmacist academician who has been teaching this course since that time is Prof. Dr. Asuman BAYTOP.

PROF. DR. ASUMAN BAYTOP

The primary goal of Pharmaceutical Botany is; teaching pharmacists drug yielding plants or plants that are used as medicine, i.e. medicinal plants.

A pharmacist shoud learn about useful plants (food-spice-dye) and especially poisonous plants and also should have vast knowledge on plants that grow in his/her country, their origins, habitats and usages.

In addition, he/she should know about the flora of his/her country to a certain extent.

PLANT SYSTEMATICS

Systematics = Biological systematics examines the biodiversity of living organisms on earth and the relationships that develop among living organisms throughout time.

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Plant systematics (Systematical Botany = Plant Taxonomy), a branch of botany that examines and identifies plants.

Systematic botany will also establish the basis of "Pharmaceutical Botany".

Plant systematics could only become a branch of science in 19th century. Botany was able to advance with the discovery of the microscope, advances in anatomy and cytology (cell science), development of genetics, introduction of the theory of evolution.

Plant systematics (Systematic Botany = Plant Taxonomy) is closely related to other branches of botany and benefits from them quiet a deal. These are:

MORPHOLOGY (morph- =Gr. form; morphologia = the science of form): Examines the inner and outer structures of the plants in respect to their forms.

In order to make a precise examination, it is divided into more specific branches such as
cytology (cyto- =Gr. cell),
histology (hist(o)-=Gr. tissue),
anatomy (anatomia = the science that deals with the structure of the living organism),
organography (organum = organ; graphia = description) and
embryology (embryo- = embryo; embryologia = anatomy of formation).

PHYSIOLOGY (physi(o)- =Gr. nature; physics): Examines the normal functioning of living organisms and investigates the vital incidents of plants based on the laws of physics and chemistry. Here, a more accurate term should be Plant Physiology.

ECOLOGY

(oec(o)-= Gr. home): Examines the relationships of plants with the environment that they live in.

PALEONTOLOGY (= Paleobotany= Phytopalaeontologia), (palaeo-= Gr. ancient; phyt-= Gr. plant): Examines the remnants of the plants that have lived in a geological era, i.e., examines plant fossils.

PHYTOGEOGRAPHY

(Plant Geography = Geobotany (gae(o)-= Gr. earth): Examines the distribution of plants throughout the earth and also examines the issues related to the formation of these distribution patterns.

GENETICS

(= Inheritance) (genesis= development; genetica= the science related to development): Examines the heredity of cababilities and the laws governing them.

EVOLUTION

Examines the individual and collective changes of plants beginning from the formation of earth till today.

CHEMOTAXONOMY

(Gr. tax(i)-= order, regularity; to arrange in an order according to a regularity) Classifies plants according to the chemical structures of their active substances.

CYTOTAXONOMY

(cyto-; taxi-) Studies the classification of plants based on the evidence related to their chromosome numbers and structures, and also cytological findings.

Plant Systematics form the foundation of Pharmaceutial Botany.
Plant Systematics primarily deal with:

1. Classification (classis= class): Classification of plants,

2. Nomenclature (nomen= name): Naming of plants,

3. Identification, Determination (determinare= to determine, identify; idens= similarity) finding the similarity, identification of plants.

1. Classifications of Plants:

The purpose of classification is grouping plants that grow throughout the earth according to their similarities and differences.

Man has grouped plants as edible plants, poisonous plants and fuel accordingly. As years have passed, the number of plants that need to be identified increased, and as a result plants had to be scientifically classified.

Theophrastus (370 BC – ca 285 BC) Born in the Island Midilli, went to Athens and performed his studies there. He was a naturalist and philosopher who had important observations in the field of botany, he identified approximately 500 plants morphologically (most of them with illustrations) and grew medicinal plants in a garden in Athens.

THEOPHRASTUS (370 BC-285 BC) is known as the father of botany and grouped plants as trees, bushes, herbs, annual, biennial, perenial and also accordng to the form of the corolla.

BOOKS HE HAD WRITTEN ON PLANTS

De Causis Plantarum
(*Examinations of Plants*)
(9 volumes)
De Historia Plantarum
(*About the History of Plants*)
(2 volumes)

Andrea CAESALPINO (l5l9-l603), Italian botanist who is considered to be the first plant taxonomist;

He grouped plants as:

- **Trees and herbs**
- **According to their fruit types and seeds and then took some other characteristics into consideration as the condition of the ovarium, plants having bulb, juice in the stem etc.**

Joseph Pitton de Tournefort (1656 -1708)

French Scientist (Naturalist)

He was sent to the east by the French government to perform botanical studies and to collect plants.

While classifying plants, he grouped them as;

- **trees and herbs,**
- **Plants with/without petals, and**
- **Flowers as actinomorph/asymmetric.**

Classifications that are implemented in taxonomy are divided into 3 main systems:

1. **Natural System**:

2. **Artifical System**:

3. **Phylogenetic System**:

Classification was not considered to be a branch of science until the 19th century.

After the discovery of the microscope, advances in the fields of anatomy, cytology,and genetics were reflected in the field of botany and new systems in classification arouse.

Today, the mostly used system in the field of sytematics is the Natural System.

According to this system, Regnum Vegetabile is divided into taxa from the biggest group to the smallest one.

REGNUM VEGETABILE

- Taxa from the biggest to the smallest group-*

Divisio = division

Subdivisio = subdivision

Classis = class

Subclassis = subclass

Ordo = order

Subordo = suborder

Familia = family

Subfamily

Tribus = tribus

Subtribus

Genus = genus

Subgenus

sectio

Subsectio

series

Subseries

Species

Subspecies

Varietas = variety

Subvariety

Forma = form

Subforma

**Taxon*, (Gr. taxis , "*arranging" ; nomia "method") is the common name that is used in the classification of plants (within a hierarchy).*

- **Any taxonomic unit or group is called a "taxon". The basic unit of all taxa is the "species".**

- A species is an individual with identical invariable characters and the offspring of a single individual.

- Individuals of a species can only reproduce among themselves, can not reproduce with other species.

- Genus, family, ordo are a taxonomic group, a taxon.

2. Nomenclature:

Nomenclature is also found among the field of plant systematics

Its purpose is to identify a plant or a plant group with a single scientific name in order to define that plant precisely without hesitation.

Establishing rules for this purpose is also within the concept of nomenclature.

Communities with different languages name plants that grow in their countries in their own languages in response to their Latin names.

Regional names can not always expected to be true and precise since every plant has a local name that changes according to the region.

Similarly, two different plants may be known with the same local name in different regions.

For example*;*

***Thymus*,**

***Origanum*,**

***Corydothymus*,**

***Satureja* species are all named as thyme;**

Trees with leaves in the form of needles are mostly referred to as Pine (but may be a *Pinus*, sometimes a *Picea* , *Cedrus* or *Abies*); *Casuarina* is also named as "Pine" in Anatolia.

Therefore, before accepting the local name, you have to see and identify a specimen of that plant and find its Latin name first.

A property, appearance, habitat, usefulness or harmfulness etc. are emphasized in the local nomenclature as well as Latin identification.

Fruits of *Styrax officinalis* *resemble prayer beads*;

***Orobanche* is a parasite, weakens the plant that it lives on.**

Mature fruits in the form of vesicles of *Leontice leontopetalum* (patpatı in Turkish) burst when squeezed.

Plants were named with a couple of words until the 18th century. But when the number of identified plants rapidly increased, nomenclature had to be made according to some rules.

The name that is used in nomenclature should be an internationally accepted language; therefore as a result of these considerations and international discussions, a neutral language, LATIN (which used to be considered as the language of science but is no longer used in conversation) was accepted as the language of taxonomy.

Carl Linnaeus (later **Carl von Linné**, **Carolus Linnaeus** in Latin books was born in Råshult in May 23, 1707 (South of Sweden), died in Uppsala in January 10, 1778; Swedish biologist, physician and physicist.

Linnaeus established the foundation of classification in biology and botany.

Linnaeus applied binomial (dual nomenclature) classification to approximately 6000 plants that he has gathered in his book named *Species Plantarum* (Planst Species) in 1753. In this classification, plants are named with a combination of two latin words.

**** bi(s)- = twice; nomen = name***
A combination is called the union of name of a genus and a name or adjective that defines a taxon.

Binomial (= dual) naming

The first word in the name of a plant is the genus name and the second word is the species name of that plant.

Genus is a special name or a word that is accepted to be a name

May have different origins, for example, may be an ancient or local name of that plant (*Rosa*), or the name of a famous person (*Cinchona*)

Genus name is singular and starts with a capital letter

In any given name, the second adjective or name that determines the name of that species is called an EPITETH.
***Pinus* (genus name) *nigra* (epiteth).**

This adjective sometimes defines the morphological characteristic of that plant:

Juniperus nana **(nanus, -a, um = dwarf): = short.**

Pinus nigra **(niger, nigra, nigrum = black)= having black trunk.**

Sometimes defines the property of an organ:

Colchicum autumnale **(autumnus = autumn): flowering in autumn**

Krameria triandra **(andr(os)- = male): with 3 stamens.**

Quercus pedunculata **(pedunculus = stalk): fruit with stalk**

Sometimes defines its habitat (the place a plant grows in):

Equisetum palustre **(palustris = growing in swamp): a swamp plant.**

Saxifraga **(saxum= rock; frangere= breaking): lives among rocks**

Sometimes emphasizes the country/city/region etc. that a plant lives in:

***Orchis anatolica*: an Anatolian plant.**

***Rosa damascena* (Damascus): Growing in Damascus**

Sometimes the region that a plant lives in is important:

Lavandula cariensis **(Caria = Muğla-Aydın region): grows around Muğla.**

Sometimes the usage or activity of a plant is expressed:

Papaver somniferum **(somnus= sleep, fera= yielding): leads to sleeping.**

Chenopodium anthelminthicum **(helmint= a kind of worm): against worms.**

If the second name is the name of a person or a geographical region, then an adjective is derived from the word, or a noun phrase is formed with its genitive; for example, *Allium nevsehirense, Gundelia tournefortii, Digitalis davisiana.*

The second name may come from mythology:

Origanum heracleoticum **(Heracles = Hercules)**
Belonging to Hercules; used by Hercules for treatment purposes

Sometimes the second name is a word that consists of two words, then a hyphen is put between these two words: like *Dryopteris filix-mas*; this second word belonging to the species almost always starts with a small letter.

Author:

A name of a person who scientifically determines a plant is written after these two latin words.

This person is the person who has named the plant with that Latin name for the first time and is called "the author of that latin name".

For example: *Orchis anatolica* BOISSIER, *Papaver* L.;

As you can see, the name of that person is sometimes written as complete and sometimes written as abbreviated (Boiss.),

The names of well-known person are abbreviated and written as a single letter (e.g. L. instead of LINNAEUS, Linné).

FAMILY

Families are formed in plant systematic by gathering genera that have similar characteristics.

Family name is a plural adjective that is used as a name. Derived from the name of a genus belonging to that family by attaching -aceae to that name:

***Malva* - Malvaceae** ***Tilia* - Tiliaceae**
***Rosa* - Rosaceae** ***Lilium* - Liliaceae**

There are some names that do not abide by this rule but are accepted since they have been used for a long time:

Gramineae, Labiatae, Compositae.

However in recent years the same rule is being applied to these families as well.
For example:

Graminae is replaced by Poaceae, Labiatae by Lamiaceae and Leguminosae by Fabaceae; but botanists are free to use the old names, as well.

Subfamily names are made by attaching -oideae to the name (*Prun*us - *Prunoideae*).

ORDER

Order is a taxon that expresses the community of similar familes.

In the nomenclature, one of the important families of that order is taken and -ales is attached:Malvales, Rosales, Fagales etc.

Some of the order names are against this rule:

Umbelliflorae, Campanulatae, Liliiflorae etc.

CLASS

The suffix in Class names may be different;

For example,

algae : -phyceae : e.g. Cyanophyceae

fungi : -mycetes : e.g. . Ascomycetes

lichenes : -lichenes : e.g. . Basidiolichenes

pteridophytes: -atae : e.g.

DIVISION

All division names end with –phyta (a Greek word for plants).

3- Identification of Plants

One of the branches of plant systematics is identification (or determination)(*). Identification of a plant means determining whether a plant is identical to a known plant, or not.

In order to identify a plant;

- You have know the plants, see and understand their characteristic structures.

If the plant to be identified belongs to a certain region, then a book that introduces the plants collected from that region is referred to (Flora or manuals).

In these books, analytical keys are found in addition to the definiton of plants. In the identification with these keys, first the family that the plant belongs to is determined, then the genus and species of that plant; during identification monographs or revisions are also useful.

FLORA; in general, is all plants growing in a region, i.e. plant species of that region.

Books covering all plants of a region is also called FLORA.

MONOGRAPH:
is a taxonomical research study that examines all species of a family or a genus throughout the world.

REVISION is a research study that examines certain plant groups of a country or a region; identification keys of the plants are also given with this study.

HERBARIUM

Herbarium is a collection consisting of dried plant specimens.

This is another source used for the identification of plants.

These plant specimens are used as comparative materials and for scientific researches. A newly identified plant may also be compared to a previously collected herbarium specimen (if any) and its identification may be confirmed.

If a similar taxon can not be found at the end of all studies performed for the identification of that plant, then it may be considered to be a new species.

The plant specimens are sent to the experts (people working on a genus or a couple of genera).

If it is confirmed that the species is new to scientific world, then an internationally accepted name is given (published with its description in Latin).

DRUG: is a plant or animal originated substance used for the preparation of medicines.

They are grouped as Herbal Drugs and Animal Drugs according to their origins. The number of herbal drugs is more than the number of animal drugs since plants are very important in human health.

Herbal drug is either a part of a plant or the whole plant or a product prepared by processing a plant /plant organ.

Mentha piperita **leaves (Menthae piperitae folium); the volatile oil obtained from the leaves with steam distillation (Menthae piperitae aetheroleum) and Mentholum crystalized from this drug are also drugs.**

The number of drugs consisting of a whole plant is few, generally parts of plants are used as drugs. For example:

Herba (herbs)

Gemmae or **Turiones** (branch bud)

Stipes, **Stipites** (branch, stalk; branches, stalks)

Summitates (branch tips)

Folium, **Folia** (leaf, leaves)

Flos, **Flores** (flower, flowers)

Stylus,**Styli** (style, styles)

Fructus (fruit)

Pericarpium (fruit peel)

Pulpa (fleshy mesocarp)

Semen (seed)

Cortex (cortex)

Lignum (wood)

Radix (root)

Rhizoma (underground body, rhizome)

Tuber, **tubera** (tuber, tubers)

Bulbus (bulb)

Gland, **glandulae** (secretory gland/glands)

Sporae (spores)

Drugs that pathologically form, obtained as a result of a process or arising as a by-products are as follows:

Gallae (gallnut)

Gummi (gum)

Gummi resina (gum with resin)

Resina (reçine)

Amylum, Amyla (starch, starches)

Succus (juice)

Cera (wax)

Pix (tar)

Oleum (fixed or volatile oil)

Oleoresina (mixture of volatile oil and resin)

Balsamum (balsam)

NAMING OF DRUGS*

Drugs are also binomially named like plants and animals.
Again Latin is used but rules are not as definite as the nomenclature of plants.
*** The general rule: the first word indicates the part or organ that is used. The second one is the obtained drug and a noun phrase is made. For example:**

Melissa officinalis : Melissa (plant)
Folia Melissae (Melissae folium): Melissa leaves (drug)

While this phrase is being prepared:

1- After the word that indicates the part of the plant, genus name is found as the second word and is written in its genitive for per Latin rules:

Salvia officinalis	**Folia Salviae**
Scilla maritima	**Bulbus Scillae**
Aconitum napellus	**Tubera Aconiti**
Digitalis purpurea	**Folia Digitalis**

2- **Species** name is also used as the second word. This rule was used by the Turkish Pharmacopoiea. But in some countries genus name are also used as the first word like. **Senegae Radix**:

Atropa belladonna	**Folia Belladonnae**
Aesculus hippocastanum	**Folia Hippocastani**
Polygala senega	**Radix Senegae**
Artemisia absinthium	**Herba Absinthii**
Pimpinella anisum	**Fructus Anisi**
Zea mays	**Amylum Maydis**

3- The second word may be the **local name** of the plant:
Orchis anatolica **Tubera Salep** (The name of the Salep plant used in the middle east)

***This nomenclature is no longer officially valid. European Pharmacopoeia uses another nomenclature system and since Turkish Pharmacopoeia is the adaptation of European Pharmacopoeia, this new nomenclature system will be used throughout the text.**

4- The second and third names are both genus and species names:

Cinnamomum cassia	**Cortex Cinnamomi cassiae**
Ammi visnaga	**Fructus Ammi visnagae**

5- Unrelatae names are also encountered:

Glycyrrhiza glabra	**Radix Liquiritiae**
Smilax ornata	**Radix Sarsaparillae**

If the drug is a product derived from the splant as a result of a process, then sometimes it is expressed with a single word; i.e.,

Astragalus microcephalus	**Tragacantha** (or **Gummi Tragacanthae**)
Papaver somniferum	**Opium** (or **Succus Papaveris**)

NAMES OF PLANT DIVISIONS

1. **Bacteriophyta** (Schizophyta, Plants that reproduce by dividing)
2. **Cyanophyta** (Blue-green algae)
3. **Phycophyta** (Algae)
4. **Mycophyta** (Fungi) – no longer considered as plants!!!!!
5. **Bryophyta** (Mosses)
6. **Pteridophyta** (Ferns)
7. **Spermatophyta** (Flowering plants)

Angiospermae

Monocotyledones

Dicotyledones

Apetalae

Dialypetalae

Sympetalae

REGNUM PLANTAE (= Regnum Vegetabile)

A) MONERA (Procaryotes)

1. Division: Schizophyta
Virus
Rickettsia
Bacteria

2. Division: Cyanophyta (Blue-Green Algae)

B) PROTISTA (Eucaryotes)

3. Division: Phycophyta (Other Algae)
Class: Flagellata
Class : Chlorophyceae
Class : Diatomae
Class : Rhodophyceae
Class : Phaeophyceae

4.Bölüm: Mycophyta (Fungi)
Subdivision : Myxomycophyta
Class : Myxomycetes
Subdivision : Eumycophyta
Class : Phycomycetes
Class : Ascomycetes
Class : Basidiomycetes
Subdivision : Lichenes

C) METAPHYTA

5. Division : Bryophyta (Mosses)
Class : Hepaticae
Class : Musci

6. Division : Pteridophyta (Ferns)
Class : Lycopodinae
Class : Equisetinae
Class : Filicinae (Ferns)

7. Division : Spermatophyta (Plants with Flowers and Seeds)
Subdivision: Gymnospermae
Subdivision : Angiospermae
Class : Monocotyledoneae
Class : Dicotyledonae
-Apetalae
-Dialypetalae
-Sympetalae

BACTERIOPHYTA

Bacteria are saprophytic or parasitic organisms having the most primitive morphological structure; they either live alone or among a colony.

- They mostly consist of a single cell and are very small; their dimensions are expressed in microns, their cell diameters are mostly smaller than 1 micron.

- They do not have a real nucleus and typical plastids.

- They do not have chlorophyll.

Bacteria have been observed for the first time in 1676 by Antonie van Leeuwenhoek with a microscope having a single lens that he had designed.

Antonie van Leeuwenhoek, the first person who has seen a bacterium by using a microscope.

Bacteria can be found everywhere in the world. Some of them are found to live in the:

- soil,
- sea water,
- depths of the ocean,
- in the earth’s crust,
- on the skin,
- in the intestines of animals,
- in acidic geysers,
- in radioactive wastes.

Typically the number of bacteria in a gram of soil and 1 mililiter of fresh water is 40 millions and 1 million, respectively.

BACTERIA ARE SO COMMON BECAUSE:

1- Their dimensions are very small and their surface area is bigger compared to their masses,

2- They have a high level of metabolic activity and can benefit from different foodstuffs,

3- They have a high level of physiological activity and therefore reproduce rapidly,

4- Their vegetative cells and spores are very durable.

BACTERIUM CELL

- 90% of a bacterium cell consists of water.

- Cell wall is not composed of cellulose, it is made from compounds that are rich in nitrogen.

- Big mucopolyholoside (mucopolysaccharides) molecules consisting of osamines and polypeptides consisting of certain amino acids are the basic substances of the bacterium cell wall.

Some bacteria are aerobic, i.e, they need oxygen to survive and grow.

Some develop in an environment that does not contain oxygen, they are called anaerobic bacteria.

Facultative bacteria can live with/without oxygen.

Chemical reactions in which bacteria play role are due to the enzymes that they contain.

They decompose the foodstuff that they are found on, and lead to foul smell and decaying of the food.

Their toxins result in diseases in humans and animals.

Bacteria are different in respect to toxicity.

a) Endotoxin producing bacteria: The toxins that the bacteria produce are accumulated in the cell of the host they live on. When the cell breaks down, toxins are released and spread.

b) Exotoxin producing bacteria : Exotoxins are being spread from the site of injection rapidly.

For example, Botulinum toxin is one of the most powerful exotoxins, produced by *Clostridium botulinum* and causes botulismus.

However these type of intoxications are not frequently encountered since canned food are usually eaten after heating and the exotoxin which is in the form of protein rapidly decomposes by heating.

But not every bacterium is harmful.

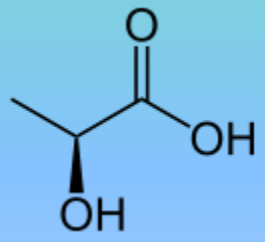
For example, *Bacillus radicicola* (*Rhizobium radicicola*) living in the soil gets into the roots of Fabaceae plants and forms small tubers called nodosites. Bacteria growing in these tubers are beneficial because they provide nitrogen to the plant.

Bacteria are grouped as follows according to their usages in the field of pharmacy:

1- Lactic Acid Bacteria

These bacteria produce lactic acid (CH_3-CHOH- COOH).

Lactic Acid



Important species in respect to food industry are found among lactic acid bacteria.

For example, *Lactobacillus lactis* has been isolated from milk and cheese.

L. bulgaricus **has been used in yoghurt production and is present in dairy products.**

L. caucasicus **is used in the production of kephry in Caucasica.**

PROBIOTICS*

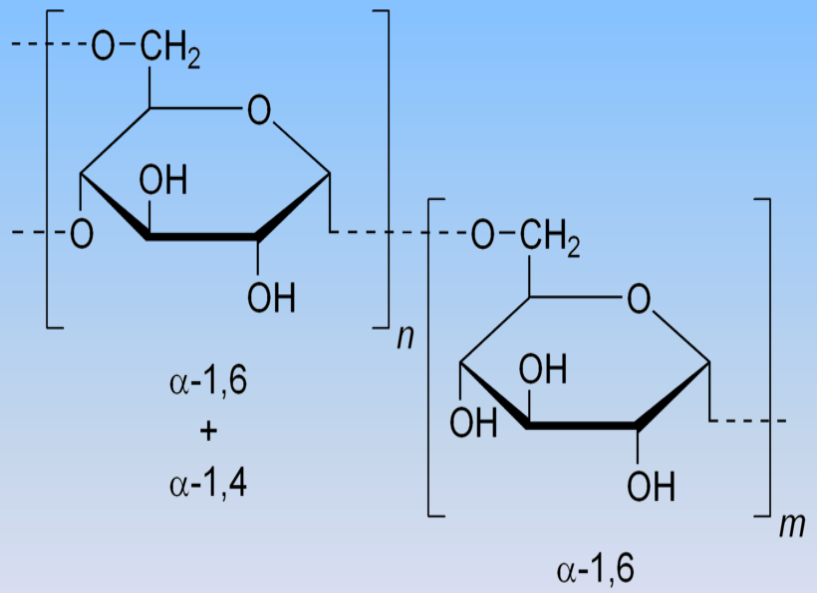
Probiotics are live microorganisms and influence the host by regulating mucosal and systemmatical immunity. In addition, they provide microbial equilibrium in the intestinal system.

Pathogenous bacteria that form as a result of drug usage or diseases attack the useful bacteria of the intestines and try to establish themselves. Probiotic bacteria cling to the intestine wall and prevent these harmful organisms from entering into.

***Lactobacillus delbruckii* and *L. thermophilus* are thermophyl bacteria and yield lactic acid.**

2-Dextran Yielding Bacteria

Dextran is a big polyholoside that started to be used during the 2nd World War instead of blood plasma.



Dextran Molecule

Since it is osmotically neutral, it is given instead of plasma in bleeding.

Used as antithrombotic in medicine, reduces the viscosity of blood and used as a volume increasing agent in anemia.

Leuconostoc mesenterioides **is used to obtain this substance.**

3- Enzyme Yielding Bacteria

Penicillinase is obtained from *Bacillus cereus* (Bacillaceae).

Alters the chemical structure of penicilline and therefore prevents penicilline allergy.

Streptokinase and Streptodornase are produced by *Streptococcus pyogenes* (= *S. hemolyticus*) (Streptococcaceae).

L-Asparaginase,

Obtained from Escherichia coli **(Eubacteriales) strains. Since it destroys L-asparagine that is responsible for the abnormal growth of cells, it demonstrates anti-cancer effect.**

4- Antibiotic Yielding Bacteria

Antibiotics are produced by microorganisms to inhibit or slow down the growth of some other microorganisms and show effect even in very diluted solutions.

Antibiotics that microorganisms yield different molecular structures and can be divided into five groups according to the chemical structure of the antibiotic:

1- Polypeptide antibiotics: e.g. **Bacitracin A**.

2- Osamine antibiotics,
e.g. **Streptomicin**

3- Tetracycline antibiotics; e.g. **Chlortetracycline**

4- Macrolides e.g. **Erythromycin**

5- Others

A) Polypeptide Antibiotic yielding bacteria:

these antibiotics generally have bactericide effect and are used locally.

1) Bacillus brevis **yields Tyrothricin.**

2) Bacillus licheniformis **is a facultative anaerobic bacterium that yields Bacitracin.**

3) Bacillus polymyxa **yields Polymyxin B sulphate (Polymyxini B sulfas,T.F.).**

4) B. polymyxa **var.** ***colistinus*** **yields Colistin (Polymyxin E).**

Streptomyces floridae*, *S. puniceus* and *Actinomyces vinaceus give **Viomycin.**

***Streptomyces orientalis*, yields Vancomycin**

B) Microorganisms producing Antibiotic with Osamine Glycoside structure

These type of antibiotics are the products of *Streptomyces* (Streptomycetaceae) species.

Some strains of *Streptomyces griseus* yield Streptomycin (Streptomycini sulfas, T.F.).

***Streptomyces fradiae* produces Neomycin (Neomycini sulfas, T.F.).**

Streptomyces kanamyceticus
produce **Kanamycin**.

Paromomycin is obtained from *S. rimosus* var. *paromomycinus*.

Gentamycin is obtained from
Micromonospora purpurea.

C) Microorganisms producing Tetracyclin Antibiotics

Streptomyces aureofaciens **produces Tetracycline hydrochloride (Tetracyclini hydrochloridum, T.F.) (Chlortetracycline).**

S. rimosus produces **Oxytetracycline**.

D) Macrolide Producing Microorganisms

Streptomyces erythreus yields **Erythromycin**
S. antibioticus yields **Oleandomycin**
S. nodosus yields **Amphotericine B**

E) Others

S. venezuelae **yields** **Chloramphenicol**