Classification of Drugs

The drugs can be classified on the basis of -

a) Chemical nature
b) Source
c) Target organ / Site of action
d) Mode of Action
e) Physical effects

a) Based on chemical nature

i) Inorganic Drugs

- **Metals and their salts**: Ferrous Sulphate, Zinc Sulphate, Magnesium Sulphate
- **Non-Metals**: Includes Sulphur

ii) Organic Drugs

- **Alkaloids**: Atropine, Morphine
- **Glycosides**: Digitoxin, Digoxin
- **Protein**: Insulin, Oxytocin
- Esters, Amide, Alcohol, Glycerides.

b) Classification based on source

i) Natural Source

- **Plants**: Morphine, Atropine, Digitoxin
- **Animals**: Insulin
- **Microorganism**: Penicillin
- **Mineral**: Sodium chloride

ii) Synthetic source

- E.g. Sulphonamides

c) Classification based on target organ:

- **Drugs acting on CNS**: Phenobarbitone

- **Drugs acting on Respiratory system**: Bromhexine
- **Drugs acting on Cardio-vascular System**: Digitoxin, Digoxin
- **Drugs acting on Gastro-intestinal tract**: Sulphadimidine
- **Drugs actin on Urinary system**: Magnesium Sulphate
- **Drugs acting on reproductive system**: Oxytocin, Estrogen

d) Classification based on mode of action:

- **Inhibitor of bacterial cell wall synthesis**: Penicillin
- **Inhibitor of bacterial synthesis**: Tetracycline
- **Calcium channel blocker**: Verapamil, Nifedipine

e) Classification based on physical effects:

- **Emollients** (substances that soften and moisturize the skin and decrease itching and flaking) Lanolin, Vaseline
- **Caustics** (substance that burns or destroys organic tissue by chemical action, generally a strong corrosive alkali): Silver nitrates
- **Demulcents** (substance that relieves irritation of the mucous membranes by forming a protective film): Zinc oxide, Tannic Acid

Sources of Drugs

Plant Sources of Drugs

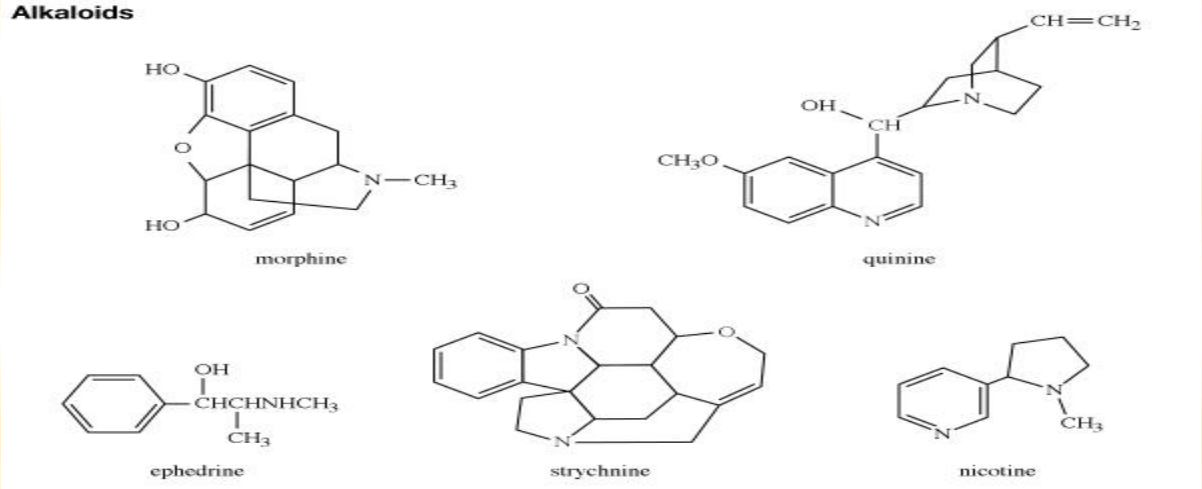
- Many drugs available from plants are even today used in the treatment of pathological conditions.
- With the increasing tendency for the use of alternate medicine, this source has gained more importance in the recent past.
- The pharmacological activities of plants are attributed to certain active principles in plants. They are - Alkaloids, Glycosides, Oils, Tannins, Saponins, Resins, Gums etc.

Alkaloids

- The term Alkaloid (Alkali-like) coined by Meissner (a German pharmacist; 1819), is commonly used to designate basic heterocyclic nitrogenous compounds commonly found

in various parts of the plants or vegetables, typically insoluble in water and physiologically active. Common examples are Morphine, Strychnine, Quinine, Nicotine, and Caffeine

- Alkaloids containing oxygen are solids and comparatively non-volatile (Cocaine) while those that do not contain oxygen are liquids and volatile (Nicotine, Lobeline and Coniine).

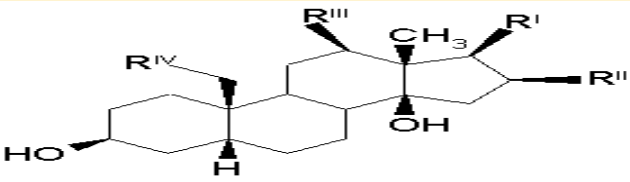


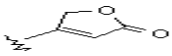
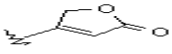
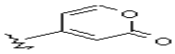
- Alkaloids are insoluble in water while their salts (Atropine Sulphate, Caffeine Citrate) are soluble in water.
- Alkaloids are bitter to taste. They are incompatible with the alkalis, tannic acid and heavy metals.
- Alkaloids represent the waste products of plant metabolism and their names end with 'ine'.
- Alkaloids should be administered in small quantities and when given in excess they may produce death without much postmortem changes for diagnosis. (Adrenaline is considered as animal alkaloid)

Glycosides

- Glycosides are non-nitrogenous substances obtained from plants in which a sugar is bound to another functional group via a glycosidic bond.
- The glycosides on hydrolysis yield two molecules namely a sugar molecule and a 'genin' or 'aglycone' molecule.
- Sugar helps in the dissolution of the preparation while the pharmacological action rests with the 'aglycone'.
- When the sugar molecule is glucose, the glycoside is known as glucoside.

- Cardiac glycosides like Digitalis, Strophanthus and Squill play a major role in the treatment of congestive cardiac failure.



	R I	R II	R III	R IV
Digitoxigenin		H	H	H
Digoxigenin		H	OH	H
Gitoxigenin		OH	H	H
Ouabagenin		H	H	H
Strophanthidin		H	H	=O
Bufalin		H	H	H

- Cyanogenic glycoside is one in which hydrocyanic acid is released on glycolysis.

Oils

- There are two types of oils namely fixed oils and volatile oils.
- Volatile oils are also known as essential oils.
- Castor oil, coconut oil etc. are fixed oils while turpentine oil, eucalyptus oil etc. are volatile oils.
- Fixed oils are obtained by expression while volatile oils are obtained by distillation. (Mineral oils are obtained from the earth and some are used pharmacologically. E.g.: Liquid paraffin.)

Tannins

- These are non-nitrogenous phenol derivatives found especially in leaves and bark.
- They are astringent in nature and form inky solutions with ferric salts. Catechu a tannic acid is used in the control of diarrhoea.
- Eg: Black catechu, Pale catechu

Saponins

- These are non-nitrogenous substances resembling glycosides.
- They are soluble in water and on shaking they give persistent foam. When the saponin is toxic it is known as sapotoxin.
- On hydrolysis saponins split into sugar and aglycone (sapogenin).
- Eg: Fenugreek, Ginseng etc.

Resins

- These are solid brittle substances formed from terpenes by oxidation. They are insoluble in water.
- Resin can be oleo resin, gum resin or balsams.
- Eg: Asafoetida, Camphor, Storax

Gums

- Gums are dried exudates obtained by incision on stems of various plants.
- They form a jelly with water.
- Eg: Gum acacia

Mineral Source

- Metallic and non-metallic minerals provide various inorganic materials not available from plants or animals. Mineral sources are used as they occur in nature or can be combined with other ingredients.
- The drugs that are included in this category include metals and their salts, non-metals, metalloids, acids, alcohols and coal tar drugs etc.
- Examples are: Sodium Chloride, Copper Sulphate, Magnesium Sulphate, Potassium Permanganate, etc.
- They are used in the purified form as drugs.

Animal Source of Drugs

- The body fluids or glands of animals are also natural drug sources. The drugs obtained from animal sources include:
    - Hormones, such as insulin

- Oils and fats (usually fixed), such as cod-liver oil
- Enzymes, which are produced by living cells and act as catalysts, such as pancreatin and pepsin
- Vaccines, which include suspensions of killed, modified, or attenuated microorganisms, or antigenic materials obtained from these

Synthetic Sources of Drugs

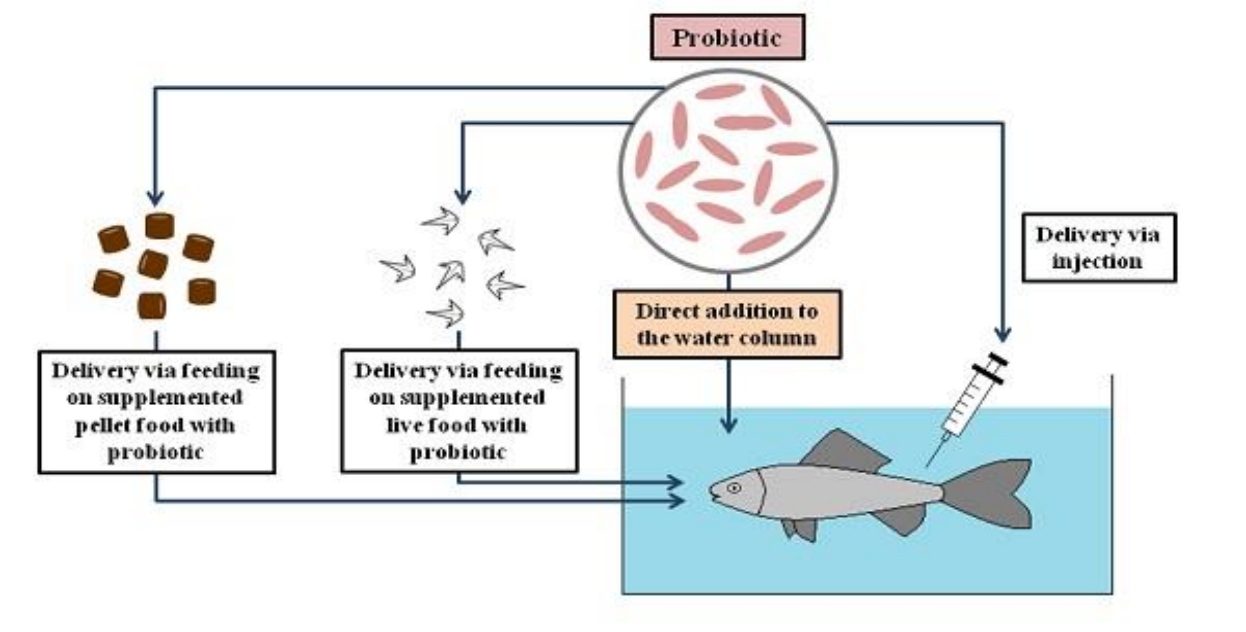
- A number of drugs synthesized in the laboratory are used most commonly.
- Even natural products such as hormones, antimicrobials etc. are also synthesized in the laboratory.

Microbial Source of Drugs

- Microbes provide an important source of drugs especially the antibiotics. All the antibiotics used against a variety of pathogens and also cancer, is obtained from fungi, bacteria or actinomycetes. Some systemic drugs like ergot alkaloids (fungal source) are also obtained from microbes.
- Eg: Penicillin from *Penicillium notatum*
- Streptomycin, Tetracyclines, Chloramphenicol from Streptomyces species

Routes of Drug Administration

The basic principle of treating aquatic vertebrates are the same as for any other terrestrial vertebrates. However, the fluid mechanics and variable nature of aquatic habitat retains few problems and requires special consideration in fish therapeutics. The poikilothermic nature of fishes must also be considered when searching for the proper drug and its route of administration. Otherwise desirable drugs may render inactive or unsuitable for use, if these considerations are ignored during therapeutics.



Water Medication: In this method, required quantity of medicine is dissolved in the water. Fish is introduced into the medicated water and maintained for required time under constant supervision. Different methods of water medication are described as follows-

a) **Immersion or Dipping**: Hold the infected fish in a dip net and then immerse or dip in a prepared chemical solution for a short period of time and then release back to their normal environment.

b) **Hyperosmotic Infiltration**: Hyperosmotic Infiltration (HI) is a development of immersion designed to accelerate the absorption of macromolecules or even of particles such as antigenic bacteria. The procedure as originally devised consists of two separate immersions. First immerse the fish is in a pharmacologically inert hypertonic solution,

10% urea and 5.23%sodium chloride for 3 minutes. Remove fish from the tank and immediately immerse the fish in the medicine or vaccine solution and then followed by the solution to be absorbed.

c) **Flushing**: In this method, fishes are kept in running water or a raceway system, wherein immersion can be achieved through flushing, which is also popularly known as, a California flush. Flushing is more wasteful, and hence more environmentally polluting, than dipping. The major drawback of this method is to obtain a homogenous distribution of the medication in water. An adaptation of this procedure is commonly used in hatcheries for the control of fungal (*Saprolegnia*) infection.

d) **Bath treatment**: In bathing the bottom of the net cage is raised, typically to 2 meters, thus limiting the volume of water to be medicated. This reduces the weight of drug required and hence reduces both the cost and degree of environmental contamination. On the contrary, bath treatment is wasteful and environmentally unsafe, and additionally labor intensive.

Oral medication: Oral administration is a route of administration where drugs are administered through the mouth. Many medications are taken orally because they are intended to have a systemic effect, reaching different parts of the body via the bloodstream. But the drawback of this medication procedure in aqua farms is its leaching effect.

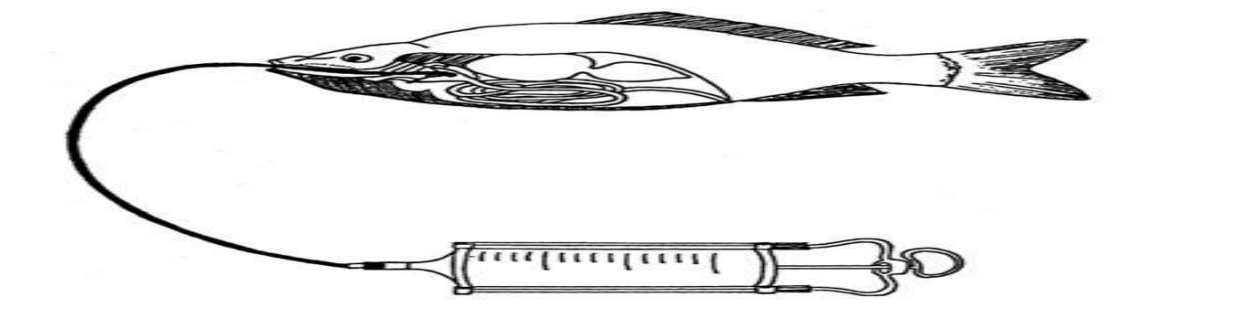
Leaching of drug into the water occurs with all forms of in-feed medication. However, major problems are associated with surface-coated feed. The extent of leaching varies according to the solubility of the active ingredient in water and the exposure time of the feed in the water. A further factor affecting the rate of leaching from medicated pellets is the size of pellets and hence the ratio of surface area to weight of pellet particle. The smaller the pellets, the faster will be the leaching.

a) **Micro-encapsulation of drugs**: A micro-capsule structure that has been well researched so far is a calcium alginate core and a chitosan-alginate shell into which the drug is mixed. Whether a micro-capsule is retained in the stomach or not is largely a question of its size.

b) **Artemia Enrichment**: To enrich artemia cysts they are decapsulated and placed in seawater which has been pre-sterilized by UV light and is well oxygenated. Artemia

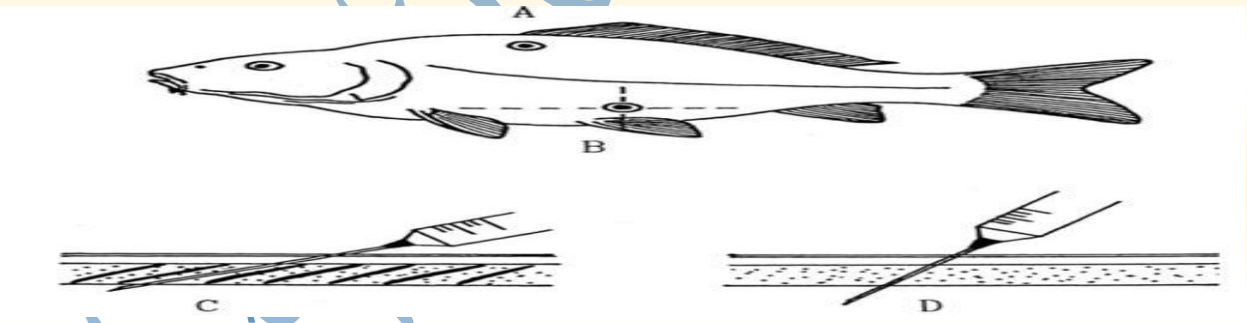
enrichment has the disadvantage of other forms of in-feed medication that only healthy fishes can be treated, also a costly and extremely wasteful method.

c) **Gavage**: Gavage is a form of oral administration extensively used in experimental work because the dose can be known accurately. It is rarely used in routine fish management as it is labour intensive and stressful to the fish. Gavage is a useful technique where a few fish such as brood fish or valuable ornamental fishes have to be dosed orally.



Injection: A prerequisite for injection is that the fish should be anaesthetized; without this precaution injury is likely to be caused to the fish and if proper care is not taken, operator might be injured as well.

a. **Intramuscular injection**: Intramuscular injections are given into the epaxial musculature, normally approximately mid-way between the mid-dorsal line and the lateral line.



b. **Intraperitoneal injection**: Intraperitoneal injections are made into the mid-ventral line just cranial to the vent. This is a widely used route of injection but it can sometimes cause peritoneal adhesions. In that case intraperitoneal injection should be avoided and the dose is likely to be made into viscera or the lumen of the gut.

c. **Injection into the dorso-median sinus**: A route of administration which is being recommended for salmonids through dorso-median sinus (DMS) injection. The point of insertion of the needle is in the mid dorsal line in the angle at the caudal margin of the

cranial dorsal fin. This route is unsuitable for most fish other than salmonids because of their different anatomy.

d. **Automatic Injectors**: Multiple dose syringes such as are available for injecting drugs into mammals rarely deliver sufficiently accurate doses of the volumes used in fish. However automatic injectors of the type used for vaccinating poultry are suitable for fish. Machines are available for the rapid injection of large numbers of fish. In practice this means vaccination by the intra-peritoneal route. Anesthesia is not needed with the machine, but even so use of the machine is safer for the operator than manual procedures with anesthesia.

e. **Implantation**: Where there is a need for prolonged medication with a drug which, for either economic or biochemical reasons, can only be administered by injection, it is sometimes formulated as a pellet or capsule for implantation. As with other injections, implantations may be intramuscular or intra-peritoneal.

Topical applications: The simplest and most direct method of treating fishes is to apply the drug directly on to the body surfaces. Wound, skin ulceration and localized infections or traumas may be treated by this method by using a concentrated solution of a suitable chemical usually an oxidizing agent, disinfectant or antiseptic. A great many drugs in the form of emulsion, linaments/ointments and lotion which would otherwise be highly useful agents are unsuitable for use in on fishes because they will either wash off, dissolve or float to the water surface because of their lighter specific gravity. In order to be useful topically, a drug must be insoluble in water, act immediately upon contact, be denser than water or be adhesive enough to adhere to the body of a fish. In this method of treatment, the individual fish must be caught and bring on to the surfaces in order to be drug applied. A wet towel thrown over the fish will allow both a firm grip to hold the fish steady and also reduce dehydration or drying out if the fish kept out of water for any length of time. Application can be made by pouring the drug directly onto the body surfaces or from a squeeze drop bottle or it can be applied with a cotton swab on the end of a small dowel. However, this is not an economically viable method for treating large group of fishes because of the time and effort involved in these processes. Such application of drugs on fish is rare; where it is done it is usually for the treatment of skin ulcers on valuable ornamental fish.