Antibiotics

Antibiotic is a substance derived from or produced by certain microorganisms (like fungi, bacteria etc.,) that can destroy or inhibit the growth of other microorganisms.

Or

Antibiotic is an organic product, which in a low concentration, is able to inhibit the metabolic activities of pathogenic organisms without harming the host.

[History: Selman Waksman introduced the word '**Antibiotic**' in 1942AD. A British bacteriologist **Sir Alexander Fleming** discovered first antibiotic under laboratory condition known as **Penicillin** from fungus *Penicillium notatum* in 1928AD. The mean of penicillin is an active substance that killed the bacteria.]

Types of Antibiotics

1. **Broad spectrum antibiotics:** Those antibiotics that able to destroy a number of different pathogens differing in structure and composition of their cell walls. For examples, Tetracycline, Chloramphenicol etc.
2. **Narrow spectrum or specific antibiotics:** Those antibiotics that able to destroy the limited number of pathogens having similar structure and composition of their cell walls. For examples, penicillin, erythromycin etc.

[Note: Other types of Antibiotic: 1. Bactericidal: The antibiotic that kill the bacteria in-vivo like Streptomycin**. 2. Bacteriostatic:** The antibiotic that inhibit the multiplication of bacteria and lead their destruction by immune mechanism like Ethambutol**.]**

Mechanism of Action of antibiotics

1. Inhibition of cell wall synthesis of other microorganisms
2. Inhibition of cell membrane function
3. Inhibition of protein synthesis
4. Inhibition of nucleic acid synthesis

Most commonly use antibiotics

S.N.	Name of Antibiotics	Micro-organisms	Applications
a.	Penicillin	*Penicillium notatum*	Tonsillitis, sore throat, rheumatic fever, gonorrhea, local infection and certain types of pneumonia
b.	Streptomycin	*Streptomyces griseus*	Tuberculosis, meningitis, pneumonia, influenza
c.	Tetracycline	*Streptomyces aureofaciens*	Viral pneumonia, osteomyelitis, whooping cough, eye infection, penicillin resistant patient, cholera,

			tetanus and also used as preservative and stimulant of growth etc.
d.	Erythromycin	*Streptomyces erythreus*	Whooping cough, diphtheria, cholera, tetanus etc.
e.	Chloramphenicol or chloromycetin	*Streptomyces venezuleae*	Typhoid, typhus fever, whooping cough, intestinal infection, bacterial urinary tract infection and typical pneumonia etc.
f.	Bacitracin	*Bacillus sutilis*	Dermatitis, dysentery

Application or use of antibiotics

1. Antibiotics are relatively less expensive, safe and sure medicines for treatment and prevention of various microbial infection
2. They are use in combating various bacterial diseases in crop plants.
3. They can be added in small quantity in animal diet specially poultry feed to prevent infection and stimulate growth.
4. They are also use as preservative in food like meat, fishes, fruits and package and canned food materials.

Vaccines

Vaccine is a liquid containing dead or attenuated (living but weak that does not cause disease) pathogen or its antigen which when injected into body, provides temporary or permanent immunity to that particular disease.

Vaccination or Immunization: Protective inoculation of vaccine into the body either by injection or orally is known as vaccination.

[Note: History of Vaccine development: Edward Jenner first introduced the vaccination in 1796 AD who inoculated mild cowpox on healthy boy to protect from small pox. In July 6, 1885AD, French microbiologist Louis Pasteur performed first experiment in immunization, when he treated a young boy against rabies. Doctor Jones Salk, an American physician developed a vaccine against poliomyelitis in mid-1950 AD. He made a vaccine from virus, which had been killed by formaldehyde.]

Types of vaccines

1. **Live or Attenuated vaccines:** These are prepared from live but weak pathogen or attenuated pathogen. These vaccines provide active life long immunity. For examples, **Oral polio vaccine** (OPV), Bacillus Calmette Guerin (BCG), small pox vaccine and influenza vaccine etc.
2. **Killed or Inactivated vaccines:** These are prepared by killing the pathogens. These vaccines stimulate the production of antibodies in the body without causing any infection. For examples, Typhoid vaccine, Salk polio vaccine, cholera vaccine, rabies vaccine, plague vaccine etc.

3. **Toxoid vaccines:** These are prepared by detoxification of toxin produced by pathogens. These vaccines provide passive immunity for short period. For example, diphtheria vaccine, tetanus vaccine etc.
4. **Cellular fraction as vaccine (Subunit vaccine):** These are prepared from extracted cellular fraction of pathogens. These vaccines provide limit duration immunity. For example, Meningococcal vaccine, Pneumococcal vaccine.
5. **Immunizing serum as vaccine (Antibodies as vaccine):** These vaccines are prepared from the serum of infected animals. Serum of infected animals have developed immunizing materials which help to cure the diseases rather than prevention. For examples, Diphtheria vaccine, Tetanus vaccine etc.
6. **Combination vaccines:** These vaccines contained more than one kind of immunizing agents. For examples, DPT (diphtheria+ pertussis+ tetanus), DP (diphtheria + pertussis), MMR (measles + mump + rubella), TI (tetanus + Influenza).
7. **First generation vaccines:** These vaccines are prepared by conventional technique using whole organisms. These vaccines have never uniform quality and produce many side effects.
8. **Second-generation vaccines:** These vaccines are prepared by recombination DNA technique or genetic engineering technology. For examples, hepatitis B vaccine, herpes vaccine etc.
9. **Third generation vaccines:** These are chemically synthesized multivalent vaccines. These have high purity. For example, Leukemia vaccine.

Application:

- Vaccines develop immunity against infectious diseases.
- They destroy or kill the pathogenic organisms.
- Vaccines can apply to the domestic animal to enhance milk and meat production.
- Vaccines are easy to use and do not have resistivity.

[**Note**: Vaccines that **safe** during pregnancy are tetanus, influenza vaccine, inactive poliomyelitis, cholera vaccine and hepatitis B vaccine etc. Vaccines that **should be avoided** during pregnancy are small pox vaccine, oral poliomyelitis vaccine and rubella vaccine]

Immunity

Immune system is the defensive system of body that protects from different types of diseases, pathogens and toxins etc. **Immunity** is a power or ability of an organism to resist the development of a disease or harmful agents.

Types of immune system:

1. **Humoral or Antibodies Mediated Immune system (AMIS):** It is formed by the antibodies. The antibody is produce by B-lymphocytes and protect the body from bacteria and viruses that enter in the blood and lymph.

2. **Cell Mediated Immune System:** It is formed by T-lymphocytes. They directly attack the pathogens (fungi and protozoans) that enter in body.

Types of Immunity: There are two main types of Immunity:

1. **Innate or Inborn Immunity**: It is present from birth and help to resist infections. It is inherited from the mother to offspring through placenta. It is not acquired from the previous attack of disease.
2. **Acquired or Adaptive Immunity**: Immunity acquired during one's own life after birth. It is developed in response to either disease caused by the organisms or disease cause by infection of microbes or vaccines. It divides into two types- active and passive immunity.

a. **Active or Natural immunity**- It is developed by an individual's own cells in response to an infection or a vaccine. It has no side effect and provides relief only after long period.
b. **Passive or Artificial immunity**: It is developed when readymade antibodies are inoculated from outside. The readymade antibody is obtained from human or animal serum, who already had recovered from an infectious disease. It provides immediate relief and may cause reaction. It is short lived due to body produce antibodies to destroy foreign antibodies.

Test tube baby technique or In vitro fertilization (IVF)

Test tube baby means a child that is conceived outside a woman's body in a laboratory through the scientific process of In-Vitro Fertilization (IVF).

In-vitro fertilization (IVF) is a technique that involved fertilizing an egg outside the woman's body in a laboratory dish, and then implanting it in the same or another woman's uterus to complete normal gestation period.

[History: IVF has been used since the late 1970s. The first "test-tube baby," **Louise Brown,** was born in England on 25 July 1978. **Robert Edwards and Patrick Steptoe**, who collaborated on the procedure, are considered to be the pioneers of IVF.]

Procedure/ IVF technique:

1. Suppression of natural menstrual cycle of woman by using a drug
2. Stimulation of ovaries of donor woman by using fertility drugs to enhance the egg production.
3. The mature eggs are collected through a minor surgical procedure.
4. Sperms are collected from the male partner or donor and then washed in cultured fluid to remove the seminal fluid.
5. The collected eggs and sperms are placed together and kept in an environmentally controlled chamber for fertilization. After a few hours later, fertilization takes place and the fertilized egg starts to divide and becomes 6-8 celled stage embryo within two days.
6. One or two selected embryos are put into the uterus of mother or surrogate mother through the vagina by using a thin tube. When the embryo sticks to the

lining of the womb and growth of healthy embryo can begin. She delivers baby after normal gestation period. The baby born by this technique is called test tube baby.

Advantage of test tube baby technique

- It boon to the childless couples.
- It provides comfort to donor mother.
- It is great achievement of medical science.

Disadvantage or Risks of Test tube baby technique

- This technique has a success rate of about less than 20%
- There is a higher chance of having twins, triplets, quadruplets or more babies.
- Chance of immature birth of baby and development of embryos outside the uterus.
- Increase health risks to the mother.

[Note:

1. **Surrogate mother:** The surrogate mother is a female that gives womb for growth and development of artificially fertilized embryo. She serves as animal incubator and delivers baby after normal gestation period. She does not contribute anything in term of genetic make-up of baby. Since the ovum comes from donor mother and sperm comes from donor father.
2. **Application of IVF technique**: This technique helps those women who are not able to conceive to give birth babies. That may be due to

- The unexplained infertility (like low ovarian reserve, Polycystic Ovary Syndrome or Endometriosis).
- Blocked fallopian tubes.
- Older patients who desire to have a child.
- Male partner infertility.]

Amniocentesis

"Technique of withdrawing a small amount of amniotic fluid from amniotic sac of pregnant woman at early stage of fetal development (15-20weeks) to analyze certain metabolites and chromosomal disorder in fetus."

[Note: The amniotic fluid is a clear, amber color fluid surrounding the fetus in the amniotic sac. It is derived from maternal plasma in early pregnancy. The fluid volume increases with growth of fetus. The amniotic fluid provides protection to the fetus, even temperature and allow the free movement of fetal growth. It also consists of fetal cells, protein and fetal urine.]

Process or Procedure of Amniocentesis

- An ultrasound is perform prior of amniocentesis for determining a safe location to insert the needle.
- Then, a long, thin needle is insert through belly into the amniotic sac of pregnant woman.
- Once the needle is inserted, a syringe is use for withdrawing a small amount of amniotic fluid. The volume of amniotic fluid withdrawn is depended on the age of fetus and types of tests to be carried out.
- The extracted amniotic fluid is send to genetic laboratory for culture of fetal cells and different types of analyzes.

Type of test

1. **Karyotype analysis or chromosomal analysis:** This test is conduct to analyze the chromosomal abnormalities in foetus like Down syndrome, Neural tube defect etc. It also helpful to find out the sex of foetus.
2. **Biochemical test:** This test is conduct to detection of the level and presence or absence of certain enzymes, hormones, proteins etc., or various metabolic features. It is useful for detection of parental diseases to the foetus.

Advantages or Positive effects of Amniocentesis:

- To detect the chromosomal abnormalities in fetus like Down syndrome, Edward syndrome etc.
- To diagnose the neural tube defects like spinal bifida and anencephaly.
- To find out the sex of baby.
- To determine presence or absence of specific enzymes, hormones.
- It helps to evaluate fetal lung's maturity.

Disadvantages of Amniocentesis:

- After amniocentesis, women may experience cramping, vaginal bleeding or leaking of amniotic fluid.
- Uterine infection such as hepatitis C or HIV is transfer to the unborn baby.
- There is risk of miscarriage in about one in 200 pregnancies after amniocentesis.
- This technique gives an opportunity to abort of the healthy female fetus in countries like Nepal.
- This test cannot determine the blood group of fetuses.
- The substantial number of sex-linked recessive genetic defects cannot be detected.

Transplantation of Tissue and Organ

Process of replacement of injured or diseased tissue or organ by healthy one of same individual or from different individual is called transplantation.

A. Tissue Transplantation: Transplantation or graft of tissue from one part to other part of body of same individual or from different individual is known as Tissue transplantation. For example; skin, tendon, bone, bone marrow etc.
B. Organ Transplantation: Graft of organ from one body to another for purpose of replacement of damaged or absent organ is called Organ transplantation. It is a decisive procedure, used when survival of an individual is in danger. Organ that transplanted are heart, kidney, liver, pancreas, lung, thymus gland, intestine etc. Christian Bernard did first heart transplantation in **1967 AD**.

[Note: **Recipient:** The person that receives the transplanted organ is the recipient. **Donor:** The person, who gives the organ, is the donor.]

Types of transplantation: According to relationship of donor and recipient, transplantation is four types:

1. **Autograft:** Transplantation or Grafting of tissue from one part of body to other of same individual is called autograft. Problem of rejection is absent in this process. For example, skin is taken from trunk and can be shifted to arm of same individual.
2. **Isograft:** Grafting of tissue or organ between individuals having same genotype such as siblings, identical twins etc., is called isograft. Rejection is not the problem in this process.
3. **Allograft:** Grafting of tissue or organs between individuals of different genotype of same species. Success rate is moderated in this process.
4. **Xenograft:** Graft of tissue or organs between individuals of different species. For e.g., from monkey to man or from pig to human. The problem of rejection is very high.

Rejection of transplanted organs or tissues: It is a process in which transplanted tissue or organ acts as antigen and stimulates the immune response in recipient body, leading to transplant failure and need immediately removable of transplanted tissue or organ from the recipient.

Treatment of Rejection:

1. **Tissue matching or typing test** must be carried out to match tissue types of the donor with the recipient before transplantation. If the tissue types are matched, success of transplantation is increased. Tissue is likely to match between genetically similar members.
2. Use of radiation or X-rays to suppress the immune system.
3. Use of immune suppression drugs to delay the rejection process.
4. Use of killer- T cells suppression medicine or monoclonal antibodies to suppress killer T cells, while the rest of immune system of patient would continue to function normally.

Condition required for transplantation

- Tissue matching should be done before transplantation to increase the success.
- Donor should not suffer from diseases like hepatitis, AIDS and Alzheimer etc.
- Transplantation should be carried when donor is alive. In case of death donor, dead body of donor must be put on life support to ensure organs of body are in still at the time of removal.

Application of transplantation

1. **Advantages:**

- It provides long life span of individual whose survival is in danger.
- It is corrective procedure of burn, injure, broken or diseased tissue.
- It is an achievement of medical science.

2. **Disadvantages:**

- It is expensive method of treatment
- Patient may die or require long term medications
- Tissue or organ rejection is the usual problem.
- It may enhance organ trafficking and lead to the exploitation of poor people.

Note: Transplantation of **Cornea** is called Keratoplasty and it is one of easiest transplantation because it is not difficult to preserve and rejection process is absent.
Cryopreservation- Preservation of organ or tissue at very cold temperature (-80 ^{0}C or -196 ^{0}C).