

# केन्द्रीय विद्यालय संगठन KENDRIYA VIDYALAYA SANGATHAN

शिक्षा एवं प्रशिक्षण का आंचलिक संस्थान, चंडीगढ़

ZONAL INSTITUTE OF EDUCATION AND TRAINING, CHANDIGARH



STUDY MATERIAL

SESSION– 2021-22

CLASS – XII

BIOLOGY

TERM - II

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KVS ZONAL INSTITUTE OF EDUCATION AND TRAINING  
SECTOR-33C, CHANDIGARH  
E-MAIL– [kvszietchd@gmail.com](mailto:kvszietchd@gmail.com), Website- [zietchandigarh.kvs.gov.in](http://zietchandigarh.kvs.gov.in)  
Ph– 0172 2621302 & 2621364

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## **OUR PATRONS**

- |                                  |  |
|----------------------------------|--|
| <b>1. Ms. Nidhi Pandey, IIS</b>  | <b>Commissioner, KVS</b>                   |
| <b>2. Dr. E. Prabhakar</b>       | <b>Additional Commissioner (Academics)</b> |
| <b>3. Mrs. Piya Thakur</b>       | <b>Joint Commissioner (Academics)</b>      |
| <b>4. Sh. Satya Narain Gulia</b> | <b>Joint Commissioner (Finance)</b>        |
| <b>5. Sh. N. R. Murali</b>       | <b>Joint Commissioner (Training)</b>       |
| <b>6. Sh. S. S. Rawat</b>        | <b>Joint Commissioner (Personnel)</b>      |

## DIRECTOR'S MESSAGE



Our aim is to provide such brief study materials and sample papers to the student that not only guides students to the path of success, but also inspires them to recognize and explore their own inner potential. The Board exam preparation is based on three pillars – **Concept Clarity, Contextual familiarity and Application Expertise**. Our innovative and dedicated teaching materials ensure that every student gets a firm grip of each of these pillars so very essential for these arduous preparations.

We also understand the importance of CBSE board exam as students' future goal depends upon the performance in board exams. We know that in pandemic situation the students feel a lot of pressure of performance in board exam. It is very important to develop the right exam temperament in students so they can tackle the pressure & surprises easily. In this direction, to release such brief study materials and sample papers will help to the students a lot.

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**CLASS – XI / XII**  
**BIOLOGY**  
**(Code No. 044)**  
**Syllabus 2021-22**

The present curriculum provides the students with updated concepts along with an extended exposure to contemporary areas of the subject. The curriculum also aims at emphasizing the underlying principles that are common to animals, plants and microorganisms as well as highlighting the relationship of Biology with other areas of knowledge. The format of the curriculum allows a simple, clear, sequential flow of concepts. It relates the study of biology to real life through the use of technology. It links the discoveries and innovations in biology to everyday life such as environment, industry, health and agriculture. The updated curriculum focuses on understanding and application of scientific principles, while ensuring that ample opportunities and scope for learning and appreciating basic concepts continue to be available within its framework. The curriculum is expected to:

- i. promote understanding of basic principles of Biology.
- ii. encourage learning of emerging knowledge and its relevance to individual and society.
- iii. promote rational/scientific attitude towards issues related to population, environment and development.
- iv. enhance awareness about environmental issues, problems and their appropriate solutions.
- v. create awareness amongst the learners about diversity in the living organisms and developing respect for other living beings.
- vi. appreciate that the most complex biological phenomena are built on essentially simple processes.

It is expected that the students would get an exposure to various branches of Biology in the curriculum in a more contextual and systematic manner as they study its various units.

**BIOLOGY**  
**(Code No. 044)**  
**COURSE STRUCTURE CLASS XII (2021 - 22)**  
**EVALUATION SCHEME**

TERM	UNIT	UNIT	CHAPTERS	MARKS
I	VI	Reproduction	2, 3, 4	15
	VII	Genetics and Evolution	5, 6	20
II	VIII	Biology in Human Welfare	8, 10	14
	IX	Biotechnology	11, 12	11
	X	Ecology	13, 15	10
TOTAL				70
Practical Term – I				15
Practical Term – II				15
GRAND TOTAL				100

**CLASS - XII**  
**BIOLOGY (TERM - I) - THEORY**

**Unit-VI Reproduction**

**Chapter-2:** Sexual Reproduction in Flowering Plants:- Flower structure; development of male and female gametophytes; pollination - types, agencies and examples; outbreeding devices; pollen-pistil interaction; double fertilization; post fertilization events - development of endosperm and embryo, development of seed and formation of fruit; special modes- apomixis, parthenocarpy, polyembryony; Significance of seed dispersal and fruit formation.

**Chapter-3:** Human Reproduction:- Male and female reproductive systems; microscopic anatomy of testis and ovary; gametogenesis-spermatogenesis and oogenesis; menstrual cycle; fertilization, embryo development up to blastocyst formation, implantation; pregnancy and placenta formation (elementary idea); parturition (elementary idea); lactation (elementary idea).

**Chapter-4:** Reproductive Health:-Need for reproductive health and prevention of Sexually Transmitted Diseases (STDs); birth control - need and methods, contraception and medical termination of pregnancy (MTP); amniocentesis; infertility and assisted reproductive technologies - IVF, ZIFT, GIFT (elementary idea for general awareness).

**Unit-VII Genetics and Evolution**

**Chapter-5:** Principles of Inheritance and Variation:-Heredity and variation; Mendelian inheritance; deviations from Mendelism-incomplete dominance, co-dominance, multiple alleles and inheritance of blood groups, pleiotropy ; elementary idea of polygenic inheritance; chromosome theory of inheritance; chromosomes and genes; Sex determination - in human being, birds and honey bee; linkage and crossing over; sex linked inheritance - haemophilia, colour blindness; Mendelian disorders in humans- Thalassaemia ; chromosomal disorders in humans; Down's syndrome, Turner's and Klinefelter's syndromes.

**Chapter-6:** Molecular Basis of Inheritance:- Search for genetic material and DNA as genetic material; Structure of DNA and RNA; DNA packaging; DNA replication; Central Dogma; transcription, genetic code, translation; gene expression and regulation - lac operon; Genome, Human and rice genome projects; DNA fingerprinting.

**CLASS-XII**  
**BIOLOGY (TERM – II)- THEORY**

**UNIT –VIII- Human Welfare**

**Chapter-8: Human Health and Diseases:-** Pathogens-parasites causing human diseases (malaria, dengue, chikungunya, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring worm) and their control; Basic concepts of immunology - vaccines; cancer, HIV and AIDS; Adolescence - drug and alcohol abuse.

**Chapter-10:** Microbes in Human Welfare Microbes in food processing, industrial production, sewage treatment, energy generation and microbes as bio-control agents and bio-fertilizers. Antibiotics; production and judicious use.

**Unit-IX Biotechnology and its Applications**

**Chapter-11: Biotechnology - Principles and Processes:-** Genetic Engineering (Recombinant DNA Technology).

**Chapter-12: Biotechnology and its Application:-** Application of biotechnology in health and agriculture: Human insulin and vaccine production, stem cell technology, gene therapy; genetically modified organisms - Bt crops; transgenic animals; biosafety issues, biopiracy and patents.

**Unit-X Ecology and Environment**

**Chapter-13: Organisms and Populations Organisms and environment:-** Habitat and niche, population and ecological adaptations; population interactions-mutualism, competition, predation, parasitism; population attributes - growth, birth rate and death rate, age distribution.

**Chapter-15: Biodiversity and its Conservation Biodiversity:-** Concept, patterns, importance; loss of biodiversity; biodiversity conservation; hotspots, endangered organisms, extinction, Red Data Book, Sacred Groves, biosphere reserves, national parks, wildlife, sanctuaries and Ramsar sites.

**PRACTICALS**  
**Max. Marks: 15 for each Term**

<b>Evaluation scheme</b>			
	<b>Term-I</b>	<b>Term-II</b>	<b>Marks</b>
<b>Part-A</b>			
One major experiment	Exp. No-1	Exp. No-3	4
One minor experiment	Exp. No-2	Exp. No-4,5	3
<b>Part-B</b>			
Spotting (3 spots of 01 mark each)	B-1,2,3,4,5	B-6,7,8	3
Practical record + Investigatory project + Viva Voice			5
<b>TOTAL</b>			<b>15</b>

Practicals should be conducted alongside the concepts taught in theory classes.

**A. List of Experiments**

**TERM - I:**

1. Isolate DNA from available plant material such as spinach, green pea seeds, papaya, etc.
2. Prepare a temporary mount to observe pollen germination.

**TERM - II:**

3. Prepare a temporary mount of onion root tip to study mitosis.
4. Collect water from two different water bodies around you and study them for pH, clarity and presence of any living organism
5. Collect and study soil from at least two different sites and study them for texture, moisture content, pH and water holding capacity. Correlate with the kinds of plants found in them.

**B. Study/observation of the following (Spotting)**

**TERM - I:**

- B.1-** Flowers adapted to pollination by different agencies (wind, insects, birds).  
**B.2-** Identification of stages of gamete development, i.e., T.S. of testis and T.S. of ovary through permanent slides (from grasshopper/mice).  
**B.3-** Meiosis in onion bud cell or grasshopper testis through permanent slides.  
**B.4-** T.S. of blastula through permanent slides (Mammalian).  
**B.5-** Prepared pedigree charts of any one of the genetic traits such as rolling of tongue, blood groups, ear lobes, widow's peak and colour blindness.

**TERM – II:**

- B.6-** Common disease - causing organisms like Ascaris, Entamoeba, Plasmodium, any fungus causing ringworm through permanent slides, models or virtual images. Comment on symptoms of diseases that they cause.  
**B.7-** Two plants and two animals (models/virtual images) found in xeric conditions. Comment upon their morphological adaptations.  
**B.8-** Two plants and two animals (models/virtual images) found in aquatic conditions. Comment upon their morphological adaptations.

**General Guidelines:**

- i. The practical examination will be of one-hour duration.
- ii. The written examination in practicals for these students will be conducted at the time of practical examination of all other students.
- iii. The written test will be of 30 minutes duration.
- iv. The question paper given to the students should be legibly typed. It should contain a total of 8 practical skill based very short answer type questions. A student would be required to answer any 5 questions.
- v. A writer may be allowed to such students as per CBSE examination rules.
- vi. All questions included in the question paper should be related to the listed practicals. Every question should require about two minutes to be answered.

- vii. These students are also required to maintain a practical file. A student is expected to record the listed experiments Term -wise as per the specific instructions for each subject. These practicals should be duly checked and signed by the internal examiner.
- viii. The format of writing any experiment in the practical file should include aim, apparatus required, simple theory, procedure, related practical skills, precautions etc.
- ix. Questions may be generated jointly by the external/internal examiners and used for assessment.
- x. The viva questions may include questions based on basic theory/principle/concept, apparatus/materials/chemicals required, procedure, precautions, sources of error etc.

Class XII Practicals should be conducted alongside the concepts taught in theory classes.

**A. Items for Identification/ familiarity with the apparatus for assessment in practicals (All experiments)**

**TERM-I:** Beaker, flask, petri plates, test tubes, aluminium foil, paint brush, bunsen burner/spirit lamp/water bath. Starch solution, iodine, ice cubes. Developmental stages of frog highlighting morula and blastula.

**TERM-II:**

Soil from different sites- sandy, clayey, loamy;  
 Small potted plants, Cactus/Opuntia (model),  
 Large flowers, Maize inflorescence.  
 Model of Ascaris

**B. List of Practicals**

**TERM -I:**

1. Study of flowers adapted to pollination by different agencies (wind, insects).
2. Identification of T.S of morula or blastula of frog (model).
3. Preparation of pedigree charts of genetic traits such as rolling of tongue, colour blindness.

**TERM -II:**

4. Study of the soil obtained from at least two different sites for their texture.
5. Identify common disease-causing organisms like Ascaris (Model) and learn some common symptoms of the disease that they cause.
6. Comment upon the morphological adaptations of plants found in xerophytic conditions.

Note: The above practicals may be carried out in an experiential manner rather than recording observations.

Prescribed Books:

- a. Biology, Class-XII, Published by NCERT
- b. Other related books and manuals brought out by NCERT (including multimedia)
- c. Biology Supplementary Material (Revised). Available on CBSE website.

Assessment Areas (Theory) 2021-22		
Class XII Biology (044)		
Competencies	Demonstrate Knowledge and Understanding	50%
	Application of Knowledge / Concepts	30%
	Analyse, Evaluate and Create	20 %

Note:

- i. Internal choice would be provided.
- ii. Suggestive verbs for various competencies
- iii. Demonstrate, Knowledge and Understanding: State, name, list, identify, define, suggest, describe, outline, summarize, etc.
- iv. Application of Knowledge/Concepts: Calculate, illustrate, show, adapt, explain, distinguish, etc.
- v. Analyze, Evaluate and Create: Interpret, analyze, compare, contrast, examine, evaluate, discuss, construct, etc.

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## CHAPTER-8 HUMAN HEALTH & DISEASE

- Health:-** A state of complete physical, mental, social well being.
- Pathogen:-**The disease causing organism ( virus, bacteria, fungus, protozoa, helminthes etc)
- Lysozyme:-** Enzyme that destroy the cell walls of many bacteria.
- Active immunity:-** Immune response generated in a person by a pathogen or vaccine.
- Anaphylaxis:-** rapidly developing severe allergic reaction that may occur in all tissues of the body; sometimes following a repeated antigenic stimulus.
- Antibodies:-** Glyco-proteins released by B-lymphocytes in response to antigens.
- Antigenic determinants-** Sites on antigens recognized by antibodies and receptors present on T and B cells.
- Antigens:-** Large, foreign molecules (e.g. proteins) stimulating the production of antibodies.
- Auto-immunity:-** The immune system turns against 'self tissue' (killing self cells).
- Clonal selection:-** Induction of B-cell clone formation by the antigen, resulting in enhanced production of the B cells (producing specific antibody) and T- cytotoxic cells.
- Disease :-** The condition of the body in which its functions are disturbed & show some symptoms.
- Haplotype:-** A set of linked genes on a homologue that tend to be inherited together e.g. A, B and C loci of the human HLA complex on chromosome no. 6.
- Immunization:-** Administration of antigen or antibody to a vertebrate animal so as to confer a state of active immunity or provide passive immunity against infection.
- Interferon:-** Proteins released in response to viral infection that render neighbouring normal cells less susceptible to virus attack.
- Passive immunization:-** Immunity attained by injecting antibodies (produced by a vertebrate in response to deliberate infection) into a non- immune individual.
- Primary immune response:-** Response mounted as a result of the first encounter of an animal with an antigen.
- Pyrogens:-** Toxins released by W.B.C. to set the body's thermostat at a higher temperature.
- Tissue typing:-** The procedure carried out to match HLA proteins of donor and recipient
- Vaccine :-** Inactivated / weakened / dead pathogens used for providing immunity.
- HIV :-** Human Immunodeficiency Virus
- SCID :-** Severe Combined Immunodeficiency
- HLA:-** Human Leukocyte Antigen

Health, well being and immunity is related to mind as the latter influences our immunity through neural and endocrine system. The knowledge of health is important due to following reasons:

- i. It brings a feeling of happiness in a person.
- ii. It increases productivity of the person.
- iii. It decreases burden of medical expenditure on the person and the government.

### **Factors affecting health:-**

- a. Genetics: Child may inherits certain disorders from parents.
- b. Infection and corresponding immunity
- c. Life style: Food / water intake, rest / exercise, habits / personal hygiene.

### **Need to remain healthy:-**

Health = Efficiency at work = Productivity = Prosperity

Health = Longevity = 1 / infant and maternal mortality rate

### **Types of diseases :**

- a. Infectious:- Can be transmitted form one person to another.
- b. Non-infectious:- Cannot be transmitted form one person to another

**Common human diseases:-**Disease occurs when the pathogen wins against host. Pathogens have to follow a specific route to cause the disease. They gain entry in the body, multiply, cause damage and thereby resulting in the appearance of symptoms.

Pathogens have to live smartly. They devise the ways to tolerate low pH in stomach, hide from the soldiers, evade being digested by the enzymes or thrown out along peristalsis.

Disease	Pathogen / Incubation period	Mode of transmission / carrier	Tissue	Symptoms	Test / Prevention
Typhoid	Salmonella typhi (1 to 3 weeks)	Contaminated food / water Housefly	Blood, Liver	Sustained high fever, fatigue, headache, Stomach perforations, death	WIDAL, Personal and domestic hygiene
Pneumonia	Streptococcus pneumoniae, Haemophilus influenzae, (1 to 3 days)	Droplet infection via Coughing, sneezing	Alveoli of lungs	Alveoli filled with fluid, reduced breathing, Fever, chills, cough, graying of lips and fingers.	Avoid contact with the patient or belongings.
Common cold	Rhino virus (2 to 4 days)	Droplet infection via Coughing, sneezing	Respiratory membrane	Nasal congestion, Discharges, sore throat, hoarse voice,	Avoid contact with the patient or belongings
Malaria	Plasmodium falciparum, P.vivax, P.malariae P.ovale (10 to 14 days)	Bite of infected female anopheles mosquito. Sporozoite form	Initially multiply in liver, then in RBC's	RBC's rupture, release of toxin-Haemozoin, Chills, anaemia, recurrent high fever	Blood smear test. Clear stagnant water, mosquito net etc.
Amoebiasis	Entamoeba histolytica	From faeces of infected person to food. Housefly	Lower part of small intestine, Large intestine	Constipation, abdominal pain, cramps, liquid stools(blood clots)	Personal, domestic and community hygiene
Ascariasis / Worms (Helminth)	Ascaris	Contaminated food, water	Intestinal Cavity	Sharing of food, Anaemia, cramps, Intestinal blocks	Community Hygiene
Filariasis / Elephantiasis (Helminth)	Wuchereria bancrofti	Bite of female culex Mosquito	Lymph Vessels	Slow chronic inflammation of organs, lymph vessels of lower limbs swell	Pillar like legs, community hygiene
Ringworms (Fungus)	Microsporum, Trichophyton, Epidermophyton	Contaminated soil cloths, comb	Skin, Moist	Dry scaly lesions on various body parts, intense itching, redness	Avoid contact with the patient or belongings

**Vector borne diseases :**

CATEGORY	INSECT	DISEASES
Mosquito	Anopheles	Malaria
	Culex	Filariasis
	Aedes	Dengue, Chikungunya, Yellow fever, Filariasis
Flies	Housefly	Typhoid, diarrhea, Cholera, T.B., Polio, Conjunctivitis
	Sandfly	Kalaazar, Oriental sore
	Tsetse fly	Sleeping sickness
	Louse	Typhus fever, Relapsing fever, Trench fever
	Rat flea	Bubonic plague

**Immunity :-** The ability of an organism to fight against pathogens

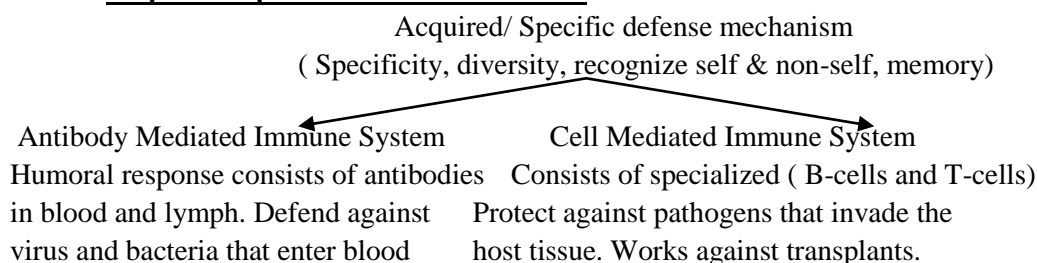
**Defense Mechanisms:-** Two lines of defense against pathogens: Innate / non-specific; Acquired /specific.

**i. Innate / Non-specific defenses:**

- a) Anatomical barrier :- The outer dry skin and inner moist mucous membrane Prevents the entry of pathogens (bacteria, virus).
- b) Physiological barrier:- Body temperature, pH, various secretions prevent the growth of pathogens (fever, acidity in stomach, lysozyme in secretions).
- c) Phagocytic barrier :- (PMNL) Macrophages, monocytes, neutrophils eat the pathogens.
- d) Inflammatory response:- An injury, breaking of mast cells, histamine and prostaglandin release, capillaries widen at the site of injury, fluid and phagocytes leaks, swelling, redness, pain and heat generation in the tissue. This inhibits and destroys the pathogen.

Besides the phagocytes, natural killer cells kill virus infected cells and some tumour cells. Complement system participates in both innate and acquired immunities

**ii. Acquired/ Specific defense mechanism**



Acquired immunity is pathogen specific and keeps a memory of the infection. The first encounter to the pathogen produces mild response but on subsequent encounters response intensifies.

CRITERIA	ACTIVE IMMUNITY	PASSIVE IMMUNITY
Naming	The person is actively involved in generating antibodies	The person is not actively involved in generating antibodies
Development	Initiation of whole array of reactions with the first exposure to the antigen	Auto- initiation does not occur
Response	Slow onset	Quick onset
Antibodies	Self generated	Readymade (from another vertebrate )
Example	Antigen contact, Vaccination	Antisera, Colostrum ( milk)

**ANTIBODY:-** They are glycoproteins (Immunoglobulins). Made up of four polypeptide chains, two light chains and two heavy chains (H<sub>2</sub>L<sub>2</sub>) that form a Y-shaped structure. Each chain consists of a permanent and temporary part. The permanent part is common for antibodies. Antigen binding sites are at the top two tips. An antibody may be free or bound to the cell membrane. Free antibodies perform three main functions such as agglutination, opsonisation and neutralization.

**VACCINATION:-** It is a solution of in-activated or weakened pathogen or antigenic preparations of proteins of pathogens introduced in the body.

Modernization (recombinant DNA technology) helps in artificial generation of copies of antigen, eliminating the chance of infection through the vaccine itself.

It is based on the principal of memory and immunity.

Procedure:-

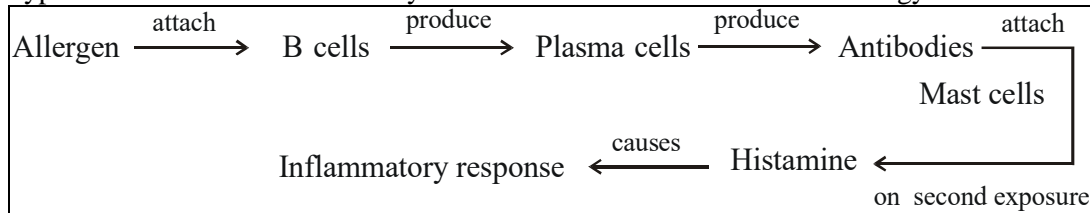
- The antigenic preparations are introduced in the body.

- The antigenic properties are recognized.
- Cascade of reactions forms antibodies (slow, weak response)
- History of reactions is stored as memory.
- Subsequent exposures results in intensified response.
- Life of memory cells varies with disease (few months to lifelong)

For infections where immediate response is required, ready made antibodies ( anti-sera) is used – Passive immunity. E.g. :- Snake bite

### **ALLERGY:-**

The hypersensitive reaction of the body to one or more substances is called allergy.



The most common symptoms of allergy are: inflammation of mucous membrane, frequent sneezing, skin rashes, watering of eyes, inability to breath etc.

Antihistamines control allergic reactions by counteracting the effect of histamines.

Adrenalin and steroids are used for symptomatic treatment. The best prevention is to keep away from the allergen.

### **IMMUNE SYSTEM OF BODY :-**

- i. Composition :- Lymphoid organs, Tissues, Cells and antibodies.
  - ii. Property :- Recognize cells, respond, memory.
  - iii. Function :- Allergic reactions, autoimmune disorders, organ transplant.
- a) **Primary Lymphoid organs:** The place of origin, maturation and proliferation of lymphocytes i.e. immature lymphocytes differentiate into antigen sensitive cells.  
e.g. :- Bone marrow, Thymus.
  - b) **Secondary Lymphoid organs:** These are the sites of inter-action of lymphocytes with the antigens. They proliferate and become effector cells.  
e.g.:- Spleen, lymph nodes, tonsils and peyer's patches of small intestine.  
Bone marrow produces primary lymphocytes. Thymus along with bone marrow provides the micro- environment for their maturation. Spleen filters antigens along with lymphocytes from the blood to produce response. Lymph nodes do the same work in lymphatic system.
- MALT:-** Mucosal associated lymphocytes provide immunity along the lining of major tracts like respiratory, digestion and urino-genital.

### **Immune System Disorders:**

**Autoimmune diseases:-** When immune system attacks and destroys self-cells and molecules  
e.g. Insulin dependent diabetes, multiple sclerosis, rheumatoid arthritis.

### **Immune Deficiency Disease:-**

- Sometimes individuals are born with reduced T-cell or B-cell and are highly prone to infections.
- SCID:- A severe form of immune deficiency where individuals are born without B-cells and T-cells.

They are highly susceptible to even minor infections.

### **ACQUIRED IMMUNE DEFICIENCY SYNDROME (AIDS):-**

- It is non-congenital deficiency of immunity. It is caused by HIV (Human immune deficiency virus- retro virus). There is a reduction in the number of helper T- cells.

- Transmitted via body fluids: unprotected sexual contact with the infected person, contaminated needles, blood-to-blood contact (transfusion) and through placenta from the mother to the fetus.
- Incubation period :- Few months to years ( 05 to 10 years)
- Infection :-
  - i. HIV attacks a macrophage, its genomic RNA enters the host cell.
  - ii. Genomic RNA forms its complementary DNA in the presence of enzyme reverse transcriptase and host machinery.
  - iii. Complementary DNA incorporates with the host DNA.
  - iv. Viral DNA forms viral proteins and genomic viral RNA.
  - v. Viral RNA and proteins integrate to form daughter virions.
  - vi. These enter Helper T-cells and repeat the process.
  - vii. Helper T-cells gets reduced and lead to AIDS symptoms.
  - viii. Patient gets susceptible to mycobacterium infections.
- High risk group:- Multiple sex partners, drug addicts, patients requiring repeated blood transfusion, children born to HIV infected mothers.
- Detection:- ELISA test, Western Blot test, PCR-DNA test.
- Treatment:- Anti- retroviral therapy , it can prolong the life for few years only.
- Prevention: - i) NACO- Do not die of ignorance.
  - ii) Safe blood transfusion- Red cross.
  - iii) Use disposable syringes .
  - iv) Away from drug abuse.
  - v) Free distribution of condoms.
  - vi) Regular checking of high risk group.

Since AIDS cannot be spread by mere physical contact so such patients must not be isolated (physically or psychology).

### **CANCER BIOLOGY & THERAPY:**

**Tumor :-** Enlargement of a tissue that occur due to unlimited/ uncontrolled mitotic divisions of certain cells. Normal cells follow the principle of ‘contact inhibition’ due to which repeated mitosis is inhibited when the cells come in contact with the adjoining cells. They also show a reduced requirement for extra cellular growth factors.

**Types :-**

- a. **Benign Tumor :-** Remain confined to their place of origin and do not spread .
- b. **Malignant Tumor:-** Neo-plastic mass of cells that undergo metastasis and spread to adjoining tissues through blood / lymph.

**Cause of Cancer :-** Transformation of normal cells into cancer may be induced by agents called carcinogens that are of following types :-

- i. Physical agents:- Ionizing radiations (X-ray, Gamma rays), non-ionizing UV ray
- ii. Chemical agents :- Tobacco chemicals alter DNA resulting in cancers
- iii. Biological agents :- Cancer causing( oncogenic) viruses have **v-onc** , some normal cells have ‘**c-onc**’, that gets activated upon stimulation resulting into cancer.

Classification based on the tissue affected :-

- a. Carcinomas:- Affect epithelial and glandular tissue (Breast & Lung cancer)
- b. Sarcomas:- Affect mesodermal tissues (Muscle tumor, Bone cancer).
- c. Leukemia:- Excessive production of WBCs in bone marrow (Blood cancer).

### **Detection and diagnosis**

- i. Blood test for abnormal W.B.C., bone marrow test or biopsy of organ.
- ii. Non-invasive technique like X-ray, C.T. scan and MRI scan
- iii. Modern technique like detecting molecular changes occurring in cancer cells.
- iv. Antibodies against cancer specific antigens have been used for certain cancers

Treatment :-

- i. Chemotherapy( use of drugs)
- ii. Radiotherapy( focused radiations)
- iii. Surgery (removal of tumors)
- iv. Immunotherapy ( antibodies)

**Side effects of cancer treatment:** - Hair loss, anemia, loss of appetite or darkening of colour. Since certain tumor cells avoid detection or destruction by immune cells, so the patients may be given biological response modifiers called **interferons**.

### DRUGS AND ALCOHOL ABUSE

It is a matter of great concern that the use of drugs and alcohol among adolescents is on the rise. The main cause of it has been attributed to improper / inadequate education and guidance besides curiosity, experimentation, peer pressure, feeling of independence.

Drugs are of following types:

CRITERIA	OPIOIDS	CANNABINOIDS	COCO ALKALOIDS
Source	Poppy (Papaver somniferum)	Cannabis sativa	Erythroxyllum coca (coco plant)
Plant part	Fruit	Inflorescence, leaves, resin	
Product	Opium, Morphine, Heroin / Smak	Marijuana, Hashish, Charas, Ganja	Coke, Crack
Intake	Snorting , Injection	Inhalation, oral intake	Snorted
Property	Neuro depressant, slow down the functions of body.	Cardio vascular effects	False sense of euphoria, Interferes dopamine (neuro transmitter) activity, Hallucinations.

Medical use of drugs is advised in certain cases. Barbiturates, Amphetamines, Benzo-diazepines, LSD are used certain kinds of depression, whereas morphine is used to induce sedation or as a pain killer during operations.

**Tobacco:-** It is the most common type of addiction in the society. It may be chewed, smoked or sniffed. It contains dozens of harmful chemicals, the main being nicotine. It stimulates adrenal glands to release adrenalin which in turn increases blood pressure. Among its ill effects are lung cancer, damage to urinary bladder / respiratory tract, emphysema, coronary heart disease, reduced haem bound oxygen in the blood.

### ADOLESCENCE AND DRUG ABUSE

Adolescence is a period during which a child progresses towards maturity hood (11-18 years). It is marked by biological and behavioral changes, so it becomes very vulnerable from psychological point of view.

Behaviors associated with it :- -Natural Curiosity -Adventure  
-Experimentation -Excitement

The first exposure is always linked with curiosity, the second one is for experimenting differently under the influence of peer pressure or media. Subsequent use indicates escapism from various pressures leading to unstable living and unsupportive family structure.

**Addiction:-** Psychological attachment to certain effects like euphoria, temporary feeling of well being associated with consumption of certain compounds. It is a negative drive that forces the addict to intake even when it is not required or besides knowing that it may cause harm. Since the response of receptors to a specific amount of drug gets reduced so the dose has to be increased that causes more harm.

**Drug Dependence:-** Manifestation of unpleasant with drawl symptoms when the drug is abruptly discontinued. Symptoms like anxiety, shakiness, nausea, sweating can push the addict to ignore social norms and incline towards criminality.

Effects of drugs and alcohol:- Immediate- Reckless behavior, violence etc.

Excess intake- Respiratory / heart failure, coma stage.

Combination of drugs and alcohol may prove lethal in case of overdosing.

**Indicators of drug abuse:**

- i. Poor academic performance
- ii. Unexplained absence from school
- iii. Poor personal hygiene
- iv. With drawl, isolation, depression
- v. Rebellious, aggressive
- vi. Changed sleep habits, weight loss
- vii. Mental and financial distress
- viii. Stealing habit
- ix. HIV-AIDS, Hepatitis - B
- x. Liver damage – Cirrhosis

Deliberate misuse of drugs (anabolic steroids) to increase performance among sportspersons is on the rise.

It has many bad effects on the body.

- i) Males:- Acne, reduced testis, reduced sperm count, kidney and liver damage, breast enlargement, baldness.
- ii) Females:- Increased masculinity, aggressiveness, mood swings, depression, abnormal menstruation, body and facial hair develop, enlarged clitoris.

Prevention and Control:-

- i) Avoid undue peer pressure: Child not be pushed to perform beyond the limits
- ii) Education and counseling: To make them face the problems and channelize energy in the positive direction.
- iii) Seeking help from parents and peers: To help the child to vent the feeling of anxiety.
- iv) Looking for danger signs: Parents, teachers be able to identify the cause.
- v) Seeking medical and professional help: For proper rehabilitation.

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**CHAPTER-8**  
**HUMAN HEALTH & DISEASE**  
**PRACTICE MCQ's**

1. The universally accepted definition of health includes:
  - i. Physical health
  - ii. Mental health
  - iii. Social health
  - iv. Emotional health
  - a. Only (i) and (ii) are correct.
  - b. Only (i) (ii) and (iii) are correct.
  - c. Only (i), (ii), (iii) and (iv) are correct.
  - d. Only (iii) & (iv) are correct.
2. Common cold is a:
  - a. Bacterial disease.
  - b. Viral disease.
  - c. Protozoan disease.
  - d. Fungal disease.
3. Malaria is caused by (A) and spread by (B):
  - a. bacteria, aedes
  - b. bacteria, female anopheles
  - c. protozoan, male anopheles
  - d. protozoan, female anopheles
4. The rupture of RBC during the infection of malaria is characterized by the release of:
  - a. Haemoglobin
  - b. Haemocyanin
  - c. Haemozoin
  - d. Haemoerythrin
5. Elephantiasis is a non lethal disease that seriously cripples the mobility. It is caused by:
  - a. Ringworm
  - b. Filarial worm
  - c. Earthworm
  - d. Pinworm
6. 'H2L2' structure corresponds to:
  - a. Antibody with 02 heavy chains outside and 02 lighter chains inside.
  - b. Antigen with 02 heavy chains outside and 02 lighter chains inside.
  - c. Antibody with 02 heavy chains inside and 02 lighter chains outside.
  - d. Antigen with 02 heavy chains inside and 02 lighter chains outside.
7. The HIV virus injects:
  - a. Viral RNA into host cell to undergo transcription & translation in cytoplasm
  - b. Viral DNA into host cell to undergo transcription & translation in nucleus
  - c. Viral DNA into host cell to undergo replication in nucleus first
  - d. Viral RNA into host cell to undergo replication in nucleus first
8. An overgrowth of a tissue that remains localized is called as:
  - a. Normal cancer
  - b. Normal Benign cancer
  - c. Abnormal benign tumor
  - d. Abnormal malignant tumor

**Assertion and Reason:**

- a. If both 'A' and 'R' are correct and 'R' is the correct explanation of the 'A'.
  - b. If both 'A' and 'R' are correct and 'R' is not the correct explanation of the 'A'.
  - c. If 'A' is correct but 'R' is false.
  - d. If 'A' is false but 'R' is correct.
9. **Assertion:** Psychotropic chemicals are a cause of concern in the present day society globally.  
**Reason:** Psychotropic chemicals are addictive and impair the thinking of a person to such an extent that the overall efficiency of the person decreases.
10. **Assertion:** Globally it is a matter of concern that adolescents are consuming more of alcohol and tobacco.  
**Reason:** School going children are getting these more of pocket money these days.

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**CHAPTER - 10**  
**MICORBES IN HUMAN WELFARE**

**Microbes:-** Small organisms that can be seen only with the help of a microscope.

**LAB:-** Lactic Acid Bacteria

**IARI:-** Indian Agricultural Research Institute.

**KVIC:-** Khadi and Village Industries Commission.

**Fermenter:-** Large vessels used to culture microbes for industries.

**Antibiotics:-** A type of bio- molecule that works against other microbes.

**Primary Sludge:-** The settled solids after the primary treatment of sewage.

**Effluents:-** The supernatant liquid that flows to the next stage during sewage treatment.

**BOD:-** Amount of O<sub>2</sub> required by the microbes to completely consume the organic wastes in one liter of the sewage/effluents under consideration.

**Biogas:-** The gaseous fuel produced by living organisms (microbes).

**Bio control:-** Use of biological methods to control pests / diseases.

**IPM:-** Integrated Pest Management

Microbes (the microscopic organisms) includes protozoa, bacteria, fungus, viruses, viroids, prions (proteinaceous infectious agents ). Their habitat includes all the extremes of survivability:-

- from +100<sup>0</sup> C to 60<sup>0</sup> C
- from low pH to High pH
- from deep in the soil to deep in snow

Bacteria and fungus can be grown on artificial culture medium for study purposes. These microbes are both useful and harmful (directly or indirectly)

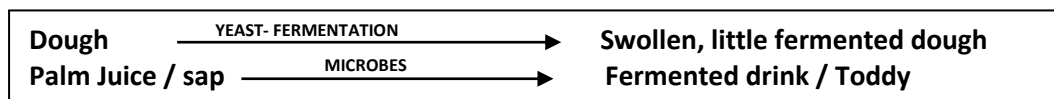
**(A) MICROBES IN HOUSE HOLD PRODUCTS:**

From ages humans have used different microbes in the household activities.



The bacteria converts some of the sugar into lactic acid, then in the presence of enzymes coagulates milk protein casein, partial digestion of protein and produce vitamin B<sub>12</sub>.

Further presence of LAB in stomach checks the growth of other microbes (so it is also added to certain antibiotics in order to prevent abdominal discomfort).



Cheese industry is flourishing on microbes. Cheese is fortified with colour, flavour and texture.

- Swiss cheese : fermented by Propionibacteria sharmanii
- Roquefort : ripened with specific fungus.

**(B) MICROBES IN INDUSTRY:**

Can we protect ourselves from diseases in the absence of anti-biotics (product of pharmaceutical industry). Fermented beverages is another example of it.

**i. Fermented Beverages:-**

Liquid food made by anaerobic digestion of carbohydrate rich food paste is called as beverage. Saccharomyces cerevisiae – microbe ( brewer’s yeast) commonly used in breweries. It is also used to make bread, fermented fruit juice and ethanol / alcohol.

The type and flavour of alcohol depends upon –

- i) Type of raw material.
- ii) Time period for fermentation.
- iii) Processing with distillation ( Brandy, Whisky) or without it ( Wine, Beer)

**ii. Antibiotics:-**

They are regarded as against microbial life but pro- human life. It works either by retarding the growth or killing the other susceptible microbe.

e.g. **Penicillin** :- Alexander Fleming's chance discovery – While working on Staphylococcus bacteria, he observed that the bacteria was not able to grow in the presence of a fungus (Penicillium notatum) in the unwashed culture dishes. Later on Ernest Chain and Howard Florey established the full nature of the molecule, that was considered to be a wonder drug during the world war.

All the three scientists jointly got the Nobel Prize in 1945 for their discovery.

Lot of antibiotics are now being used to save humanity.

**iii. Other Chemicals / Enzymes / Bioactive molecules:-**

Lot of organic acids, alcohol, enzymes are also obtained from microbes.

e.g.

S.No	MICROBE	CATEGORY	PRODUCT
1	Aspergillus niger	Fungus	Citric Acid ( preservative)
2	Saccharomyces	---do---( yeast)	Ethanol / alcohol
3	Acetobacter aceti	Bacteria	Acetic Acid ( kitchen preservative)
4	Clostridium botylicum	---do---	Butyric Acid
5	Lacto bacillus	---do---	Lactic Acid
6	Streptococcus	--do---	Streptokinase ( clot buster enz.)
7	Trichoderma polysporum	Fungus	Cyclosporin-A (Immunosuppressant, used in organ transplant cases)
8	Manascus purpureus	--Do--( yeast)	Statin (Blood cholesterol lowering agent)

- Statin competitively inhibits the enzyme responsible for synthesis of cholesterol.
- Industrial products that become efficient due to the presence of biomolecules are-
  - Detergents contain enzyme Lipase to remove oil stains.
  - Clarity of bottled fruit juice is due to the use of enzyme Pectinase and Protease.

**(C) MICROBES IN SEWAGE:**

Every activity produces by-products / end products, which if of no use will be called as wastes. Since per unit area population has increased tremendously, so are the processes and hence the wastes. Accumulation of wastes is posing a great problem to the city / town management.

The beauty of the nature is that the wastes generated by one system becomes raw material for the other system. Here comes the role of microbes (the ultimate consumers), but they also have their limit to consume naturally. Wastes cannot be stored for longer duration (cause for spread of diseases), nor they can be disposed directly to a water body (death of aquatic system), so artificial systems (Sewage Treatment Plant-STP )have to be devised to degrade wastes in such huge quantities.

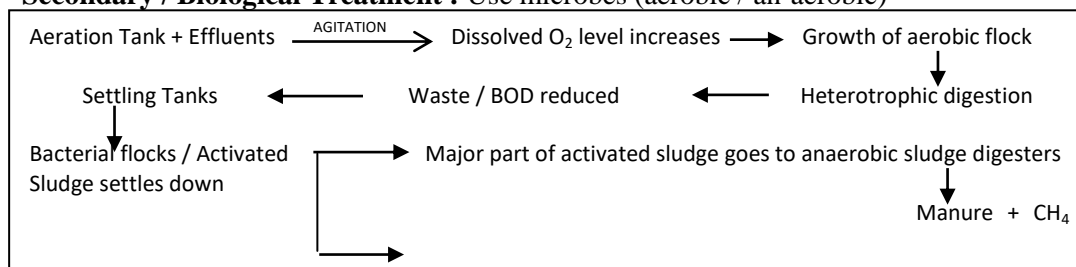
**Sewage Treatment Plant ( STP )** requires raw sewage and a group of heterotrophic microbes. Treatment involves two steps:- Primary / Physical and Secondary / Biological.

a) **Primary / Physical Treatment:-** It involves-

- i. Filtration:- Removal of floating debris (leaves, wood, polythene bags, paper).
- ii. Sedimentation:- Allow the sewage to stand still or reduce speed so that the particulate matter settles down (Primary Sludge).

Effluents ( supernatant liquid ) is allowed to flow to the next stage.

b) **Secondary / Biological Treatment :** Use microbes (aerobic / an-aerobic)



**BOD** (Biological Oxygen Demand) is an indicator of organic pollution in water.

Composition of biogas in the above process is:- CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S (alternate source of energy)

The solid matter obtained forms a good organic manure. The effluents can now be discharged in the water body.

STP / ETP form an integral part of Ganga and Yamuna Action Plan.

#### (D) MICROBES IN PRODUCTION OF BIOGAS:-

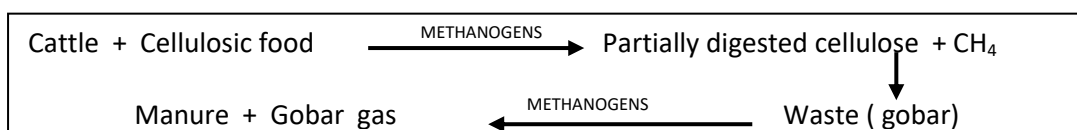
Microbes in the service of society – Providing clean alternate fuel (Biogas).

Biogas is the by-/end product of microbial activity. Composition of biogas depends upon

- Type of microbe
- Organic raw material.



Methanogens are naturally found in Rumen of cattle and Sewage .



Working of biogas plant :-

- Digester / Concrete tank (10 – 15’ deep) with a floating cylindrical cover.
- Addition of Sludge (Bio waste) and Slurry of cow dung.
- Fermentation of slurry by methanogens.
- Production of CH<sub>4</sub> and residue called manure.
- Gas is collected in the floating cylinder which rises as gas is filled.
- Gas is channelized for use as fuel.

Its technique was developed jointly by IARI and KVIC.

#### (E) MICROBES AS BIO-CONTROL AGENTS:-

Use of living organisms to control the pests or diseases in a natural way. It is a replacement for insecticides/pesticides, which are ecologically harmful (directly or indirectly) to other life forms and even poison the soil.

##### Biological control of pests / disease :-

**Principle:** Bio predation-as a part of food chain. Each organism is a part of some food chain.

It gives us a reason to save Bio-diversity.

**Conventional farming** – Chemical pesticides kill both the useful and harmful insects. This destroys the food web and hence the biodiversity and ecosystem.

##### **Bio-farming:**

- It is based on thorough knowledge of food chains & food web.
- Harmful insects are not eradicated but are kept at manageable level by checks / counter checks.

So, nature is maintaining itself by a complex system of webs( natural way of sustain life)

Production of pesticides is:

- Labour intensive
- Harmful to nature
- Reduce bio-diversity.

Prey	Method of damage caused by prey	Predator
Aphids	Suck plant juices, may spread diseases	Lady Bird Beetle
Mosquito	Spread a lot of diseases	Dragon fly
Butterfly Caterpillar	Feed on leaves and reduce productivity	Bacillus thuringiensis
Soil based root damaging plant pathogens	Kills pathogens in the root system	Trichoderma (free living soil fungus)
Pests in general (Those requiring highly specific)	Damage as above	Baculovirus (Nucleo-poly-hedron)-Narrow

approach) as in IPM-Integrated Pest Management		spectrum highly specific action
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Bacillus thuringiensis (bacteria) have a gene (**Bt-gene**). This bacteria is available as powder/spores for the farmers. It is mixed with water and sprayed. Caterpillar feeds on such leaves. In the gut of insect, bacteria comes out of its spore, releases toxins that kills the caterpillar.

**Genetic Engineering approach: Bt-Cotton:-**

Bt-gene has been introduced in crops like cotton by r-DNA technology (protection from boll worm which is actually the caterpillar stage of butterfly).

**(F) MICROBES AS BIO-FERTILIZERS:**

Environment Pollution is directly proportional to use of chemical fertilizers.

Effective approach – Organic Farming (Bio-Farming).

Bio-fertilizers include – Bacteria, Cyanobacteria, Fungus.

e.g. -

Microbe	Host plant	N <sub>2</sub> Added	PO <sub>4</sub> added	Manure added decomposition of
Rhizobium bacteria	Root nodules of legumes	Yes	After decay	Roots of host plant
Azospirillum	Nil ( free living)	Yes	--do--	Nil
Azotobacter	Nil ( free living)	Yes	--do--	Nil
Cyano-bacteria	Ferns + free living also	Yes	--do--	Body of fern plant
Mycorrhiza	Roots of higher plants	Little	Solublize it	Roots of the host

Cyano-bacteria includes the blue green algae – Photo-auto-trophic, N<sub>2</sub> fixers. They may be symbiotic or free living fixers. It is effective approach in paddy fields.

Mycorrhiza (Genus- Glomus) forms symbiotic association with the roots of trees.

Advantage –

- i. Increase surface for absorption.
- ii. Solublize and make phosphate available to the host root.
- iii. Provide resistance to the root borne pathogens
- iv. Increase tolerance to salinity
- v. Increase tolerance to drought
- vi. Result rapid growth and development of plant.

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**CHAPTER - 10**  
**MICROBES IN HUMAN WELFARE**  
**PRACTICE MCQ's**

1. What role does LAB plays in the human day to day activities:
  - i. Dhokla formation
  - ii. Curd formation
  - iii. As a combination with antibiotics
  - iv. Cheese formation
  - a. Only (i) and (ii) are correct.
  - b. Only (ii) and (iii) are correct.
  - c. Only (i), (ii), (iii) and (iv) are correct.
  - d. Only (iii) & (iv) are correct.
2. The bacterium 'Propionibacterium sharmanii is used in the production of:
  - a. Toddy
  - b. Swiss cheese
  - c. Roquefort cheese
  - d. Dough for bread
3. The basic process of industrial production of Wine is (A) and that of Whisky is (B):
  - a. With distillation, with distillation
  - b. With distillation, without distillation
  - c. Without distillation, without distillation
  - d. Without distillation, with distillation
4. The microbes play a crucial role in industry. Given below is a list of microbe and the concerning product. Select the correct combination of matching the microbe & its product:
  - i. Lactobacillus (a) Acetic acid
  - ii. Aspergillus (b) Butyric acid
  - iii. Clostridium botulinum (c) Lactic acid
  - iv. Acetobacter (d) Citric acid
  - a. (i-a),(ii-b), (iii-c), (iv-d)
  - b. (i-b),(ii-c), (iii-d), (iv-a)
  - c. (i-c),(ii-d), (iii-b), (iv-a)
  - d. (i-a),(ii-d), (iii-b), (iv-c)
5. In myocardial infarction, some type of clots are formed in the blood vessels that block the vessel supplying blood to the heart itself. This can be taken care of by the use of:
  - a. Saccharomyces
  - b. Streptokinase
  - c. Streptococcus
  - d. Cyclosporin-A
6. All the solids that settle down in the physical treatment of sewage constitute:
  - a. Activated sludge
  - b. Anaerobic sludge
  - c. Primary sludge
  - d. Secondary sludge
7. The requirement of phosphorus by the plants on the hill slopes is met by:
  - a. Mycorrhiza
  - b. Rhizobium
  - c. Anabaena
  - d. Oscillatoria
8. Rhizobium, Anabaena and Nostoc come under the category of:
  - a. Microbes constituting biopesticides
  - b. Microbes constituting biofertilizers
  - c. Microbes constituting pathogens
  - d. Microbes constituting predators

**Assertion and Reason:**

- a. If both 'A' and 'R' are correct and 'R' is the correct explanation of the 'A'.
- b. If both 'A' and 'R' are correct and 'R' is not the correct explanation of the 'A'.
- c. If 'A' is correct but 'R' is false.
- d. If 'A' is false but 'R' is correct.

9. **Assertion:** The sewage constitutes lot of manageable organic decomposable matter.

**Reason:** The organic matter can be reduced by aerobic process in the STP.

10. **Assertion:** A practical answer to pests is rDNA technology that incorporates genetic modification of crops.

**Reason:** Bt-cotton and Bt- brinjal have the property of resisting pest attack because of rDNA technology.

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**CHAPTER - 11**  
**BIOTECHNOLOGY: PRINCIPLES AND PROCESSES**

- **Biolistic** (Particle Bombardment/micro-projectiles): involves directly "shooting" a piece of DNA into the recipient plant tissue. This is carried out by a gene gun.
- **DNA cloning:** The production of a lineage of cells all of which contain one kind of DNA of interest, derived from a population of many kinds of DNA fragments.
- **DNA ligase:** Involved in the replication and repair of DNA molecules. It catalyses the formation of a (phosphodiester) bond between the 5' and 3' ends of the nicked DNA backbone.
- **DNA polymerases:** It catalyze the synthesis of new DNA molecules from single stranded DNA templates.
- **Electroporation:** is a mechanical method used to introduce polar molecules into a host cell through the cell membrane. It involves creation of temporary disturbance in the phospholipid bilayer by a short electric impulse, allowing molecules like DNA to pass into the cell
- **Escherichia coli (E. coli):** A Gram negative, rod-shaped bacterium which inhabits the lower intestines of most mammals. It is the organism of choice for research because it grows at a wide range of temperatures, have minimal nutrient requirements. In addition, E. coli has yielded a wide variety of restriction endonucleases including EcoRI, EcoRI', EcoRII, EcoB, EcoK, EcoPI, and EcoPI5.
- **Gene cloning:** is a process by which large quantities of a specific, desired gene or section of DNA may be cloned or copied once the desired DNA has been isolated.
- **Genetic engineering:** Use of techniques involving recombinant DNA technology to produce molecules and/or organisms with new properties
- **In vitro packaging:** used to package DNA cloned onto a lambda vector into infectious lambda particles.
- **Insertional inactivation:** The inactivation of a gene by inserting a fragment of DNA into the middle of its coding sequence. Since the actual sequence of the gene gets disturbed due to insertion of foreign DNA segment, so the new sequence will either not form any product or the protein formed will not be able to function as desired. So the gene with insertion has been silenced.
- **Microinjection:** refers to the process inserting microscopic substances into a living cell using a micro needle.
- **Nitrocellulose:** A membrane used to immobilize DNA, RNA, or protein, which can then be probed with a labelled sequence or antibody.
- **Nuclease:** An enzyme that degrades nucleic acids (DNA/RNA) by cleaving the phosphodiester bonds that link adjacent nucleotides. (DNAase/ RNAase)
- **Endonuclease:** A nuclease that cleavage at somewhere in the middle of DNA.
- **Exonuclease:** A nuclease that progressively cleaves from the end of DNA.
- **Origin of replication:** It is a particular DNA sequence at which DNA replication is initiated. DNA replication may proceed from this point bidirectionally or unidirectionally.
- **Palindrome:** A nucleotide sequence, composed typically of 4, 6, or 8 nucleotides, that is recognized by a restriction endonuclease for cleavage at a specific point.
- **PCR:** Polymerase Chain Reaction rapidly amplifies a single DNA molecule into many billions of molecules.
- **Plasmid:** An extra-chromosomal, circular DNA molecule (found naturally in many bacteria and also in some yeast), capable of autonomous replication and carrying few specific genes encoding antibiotic resistance. Plasmids can transfer genes between bacteria and are important tools of transformation for genetic engineers.
- **Probe:** A single-stranded DNA (an oligonucleotide) that has been radioactively labelled and is used to identify complementary sequences in genes or DNA fragments of interest
- **Recognition sequence:** The specific nucleotide sequence to which a restriction enzyme binds prior to cutting the DNA backbones. Recognition sequences are generally 4, 5, or 6 base pairs in length (palindrome) and are read the same forward & backward direction.

- **Recombinant DNA technology:** The application of genetic tools (restriction endonucleases, plasmids and transformation) for the production of specific proteins by biological "factories" such as bacteria
- **Recombinant DNA:** DNA molecule produced artificially and containing sequences from unrelated organisms
- **Restriction enzymes:** Endonuclease which recognize specific sequences of bases in a DNA molecule. Each restriction enzyme has a single, specific recognition sequence, and clips the DNA molecule at a specific site. *EcoRI* (GAATTC) and *HindIII* (AAGCTT)
- **Sticky ends-** They are short, open complementary portions of the palindromic DNA sequence produced by the action of a restriction endonuclease. Sticky ends allow the joining of segments of DNA from different sources
- **Gene gun** is a device for inserting specific genetic information (DNA) adhered to a micro projectile (bullet), into a recipient plant cell by applying pressure like an air gun for bringing transformation.
- **Ti plasmid (T-DNA):** *Ti* plasmid DNA, present in *Agrobacterium tumefaciens*, is inserted into the host plant. This DNA produces growth hormones which result in the tumor and provides a habitat for the bacteria. The *Ti* plasmid can be used as a transformation vector.
- **Transduction:** Transfer of genes from one bacterium to another, by a bacteriophage (bacterial virus) acting as the carrier of the genes.
- **Transformation:** The process of introducing a piece of DNA from medium into a host bacterium.

**Biotechnology:** Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

Two core techniques that enabled birth of modern biotechnology are:

1. **Genetic engineering:** It is a technique where a gene or set of desirable genes from its source DNA molecule is inserted / integrated into another or target DNA molecule for some specific purpose. This technique has overcome the limitations in traditional hybridization procedures which lead to inclusion and multiplication of undesirable genes along with desirable genes.
2. **DNA Cloning:** The production of a lineage of cells, all of which contain one kind specific kind of DNA fragment (Gene of interest), derived from a population of many kinds of DNA fragments.

### TOOLS OF RECOMBINANT DNA TECHNOLOGY:

#### 1. Nucleases (enzymes):

Restriction enzymes (RE)	DNA polymerases	Reverse transcriptase	DNA ligase
They are of two kinds: i) Exo-nuclease:- remove nucleotides from the ends of DNA. ii) Endo-nuclease:- cuts at specific positions within DNA iii) Enzymes (nucleases) recognize a specific sequence and cuts DNA at a specific base pair. e.g. <i>EcoRI</i> always recognize GAATTC & cuts DNA at G-A	Enzymes which synthesize DNA using a single-stranded template	An enzyme that uses RNA molecule as a template for the synthesis of a complementary DNA strand	An enzyme that seals two DNA fragments (eg: join the target DNA with the vector DNA)

**Naming of RE:** based on the bacteria in which they are isolated in the following manner:

E	Escherichia	Genus
Co	Coli	Species
R	RY13	Strain
I	First identified	Order in which the enzyme was isolated in the same strain of bacterium



S.No	Enzyme	Source	Recognition Sequence	Cleavage site
1	EcoR I	Escherichia coli	5'GAATTC 3'CTTAAG	5'---G AATTC---3' 3'---C TTAA G---5'
2	BamH I	Bacillus amyloliquefaciens	5'GGATCC 3'CCTAGG	5'---G GATCC---3' 3'---CCTAG G---5'
3	Hind III	Haemophilus influenza	5'AAGCTT 3'TTCGAA	5'---A AGCTT---3' 3'---TTCGA A---5'
4	Taq I	Thermus_aquaticus	5'TCGA 3'AGCT	5'---T CGA---3' 3'---AGC T---5'

**2. Vectors:** A vector is a DNA molecule into which foreign DNA(gene of interest) can be inserted which can then replicate in an appropriate cell.

**3. Target DNA:** the target DNA must be joined to another DNA that can replicate (the vector). Target DNA can be of several forms including:

- **Chromosomal DNA** (Genomic DNA) isolated directly from cells or a tissue
- **Complementary DNA (cDNA)** made *in vitro* (in the test tube) using the enzyme reverse transcriptase and isolated mRNA as template.
- **Synthetic DNA** (rarely), made by machines that rely on organic chemistry

#### 4. Essential techniques in working with DNA

Technique	Description
Hybridization probe	After denaturing double stranded DNA, each strand of DNA can <b>hybridize</b> with any externally added, radioactively labeled DNA / RNA containing complementary base sequence.
Gel electrophoresis	DNA, being negatively charged moves towards the + pole (anode) of an <b>electrical field</b> . Since all DNA has a uniform charge to mass ratio, DNAs of all sizes move about equally through water. Gel of Agarose has micro capillary like arrangement through which molecules can travel, the smaller the molecule is the faster it will travel, when the gel is placed in buffer medium attached to electrodes. This helps in segregating the DNA fragments based on size.
Southern blotting	A DNA hybridization procedure in which one or more specific DNA fragments are detected in a larger population by means of hybridization to a complimentary, labeled nucleic acid <b>Probe</b> .
Polymerase chain reaction	It is in-vitro multiplication/amplification of DNA using its constituent nitrogen bases. It uses a pair of specific synthetic oligonucleotide primers and repeated cycles of DNA replication (denaturation, annealing, extension) to amplify the specific DNA region (between the primer binding sites). Very little starting DNA is needed because the amplification is exponential

#### 6. Returning recombinant DNA into a living cell (host organism)

Bacteria	Animal cells	Plant cells
1. Transformation with pure DNA 2. In vitro packaging.	1.Through animal virus vectors 2.Transfection with calcium phosphate-precipitated DNA 3. Electroporation 4.Microinjection into nucleus.	1.Electroporation 2.Particle gun 3.Microinjection 4.T-DNA

## **II PROCESSES OF RECOMBINANT TECHNOLOGY: It involves**

- Isolation of DNA
- Fragmentation of DNA by restriction endonuclease
- Isolation of a desired DNA fragment
- Ligation of DNA fragment into a vector
- Amplification of gene of interest using PCR
- Transferring the recombinant DNA fragment into a host
- Culturing the host cells in a medium
- Extraction of the desired product
- Downstream processing

### **A. Isolation of the Genetic material DNA:-**

Since DNA is enclosed within the membranes and it needs to be in pure form, the bacterial cells/plant or animal tissues are treated with enzymes such as lysozyme, cellulase, chitinase, ribonucleases and proteases. Purified DNA can be precipitated out after the addition of chilled ethanol.

### **B. Cutting of DNA at specific locations:-**

Purified DNA molecules are incubated with restriction enzyme (RE) at optimal conditions for that specific enzyme. Each Restriction endonuclease recognizes a specific palindrome nucleotide sequence in the DNA. Depending on how the cleavage is made by each enzyme, we can end up with fragments having blunt ends (HindII) or sticky (cohesive) ends, due to staggered cuts creating overhangs of single stranded DNA. Restriction enzymes recognize palindromic sequences from 4 to 8 bases. The least the number of bases, the higher the frequency of those sites in a genome.

### **C. Isolation of a desired DNA fragment:-**

- The DNA fragments are separated based on size by gel electrophoresis using agarose medium.
- The DNA fragments are denatured by soaking the agarose gel in alkali and then transferred to a nylon membrane to which they tightly bind. (**Sothern blotting**).
- The membrane-bound-DNA is soaked in a solution containing radioactively labeled probe-DNA. It is then incubated at a specified temperature so that only the probe DNA strands that have a high degree of complementarity to DNA strands (bound to the membrane), will be able to bind to each other.
- This is followed by washing using a buffer, which washes away unbound probe.
- Now whatever remains on the nylon sheet is the bound DNA.
- The position of the bound probe is determined by autoradiography.
- The entire procedure is called Hybridization.

### **C. Ligation of DNA fragment into a vector:-**

- The isolated desired DNA fragment and the vector DNA samples are mixed.
- Since the fragments of DNA that has been cut with same RE have same unpaired nucleotides at the ends, so they form sticky ends.
- Fragments with complementary sticky ends join together forming **recombinant DNA** (contains gene from vector & the gene of interest to be cloned)
- Enzyme DNA ligase seals the fragments together forming a complete rDNA molecule.

### **D. Amplification of gene of interest:-**

Once a recombinant DNA molecule is made, it must be multiplied / amplified in number to have large quantities of the molecule for analysis and further manipulation. There are two general ways to generate large quantities of DNA molecules:

#### **i. In vitro DNA replication: The polymerase Chain Reaction (PCR)**

The components are:

- a. A sample of the target DNA to be copied.

- b. A set of short (15 to 40 bases) single stranded DNA (**Primer DNA**), in **excess**, that will bind to complementary regions of the **target DNA** molecule.
- c. Ample amount of the four nucleotide triphosphates (ATP, GTP, CTP, TTP).
- d. The enzyme DNA polymerase.
- e. Various buffers and cofactors like magnesium ions required by DNA polymerase.

A single PCR amplification cycle involves three basic steps:-

- **Denaturation**:- The target DNA is heated up to 94°C resulting in the separation of two strands.
- **Annealing**:- Two synthetic oligonucleotide primers are added to the sample tubes with target DNA at 45-60°C. The primer joins (annealed or hybridized) with complementary sequence of target DNA.
- **Extension (Elongation)**:- Temperature is increased again to 90°C. Human DNA polymerase denatures at this temp. so there is requirement of a relatively stable (thermophilic DNA polymerase). Bacteria 'Thermus aquaticus' has the answer. 'Taq polymerase derived from the bacteria can tolerate high temperatures (e.g. 90°C) for long periods without being destroyed. The 3' OH end of the primers are recognized by DNA polymerase to form new complementary strands to the two original ones in the 5' direction.

The above steps are repeated as per requirement to amplify the DNA by a factor of  $2^c$ , where 2 is the number of strands and 'c' the number of cycles.

## ii. DNA Cloning:

DNA cloning is the amplification or multiplication of recombinant DNA molecules in a living host cell (GMO) such as bacteria. The features that are required to facilitate cloning into a vector are:

- a) One or more **origin of replication** (ori) site on the vector DNA.
- b) Same palindrome site so that RE may cleave and result in sticky ends.
- c) A dominant selectable marker to allow selection of cells containing the recombinant plasmids (e.g. : Antibiotic resistance) to the cell.

## TYPE OF VECTORS:

**1. PLASMID**:- It is extra-chromosomal circular DNA in a bacteria. It is able to replicate autonomously.

e.g.: Vector 'pBR322' constructed by Bolivar and Rodriguez, which contains Tetracycline and Ampicillin resistance genes with specific palindromes within the gene. A foreign DNA fragment can be integrated into the plasmid at the Bam HI site of tetracycline resistance gene in the vector pBR322. The recombinant plasmids will lose tetracycline resistance due to insertion of foreign DNA (Insertional Inactivation) but can still be selected out from the master culture plate.

Procedure: To detect rDNA plasmid (Replica plate experiment):

- Bacteria sample is grown in culture medium forms different colonies, each colony representing progenies of one bacterium.
- A replica culture plate is formed and ampicillin antibiotic is added.
- Those surviving will have either the native (non-recombinant) or recombinant plasmid.
- A second replica plate containing both ampicillin and tetracycline are added.
- This replica plate helps to identify the required GMO in the tetracycline plate
- The bacterial colony still surviving is not the required one (non-recombinant).
- The bacterial colony that disappears (cells with recombinant plasmids do not grow in presence of tetracycline since the **tetracycline resistant gene is disabled by insertion** of foreign DNA) are the required ones hence to be selected.
- By subtraction, the recombinant DNA colonies are then identified and isolated from the first plate containing only ampicillin.

2. **Phages:** Virus that infects a bacteria is called as phage. Phage vectors are derivatives of the lambda phage.
3. **Yeast artificial chromosomes (YACs) & Bacterial artificial chromosomes (BACs)** are good artificial DNA vectors that serve to clone 100 to 300 kb fragments.
4. **Expression vectors:** These vectors permit the expression of cloned sequences by incorporating appropriate transcription and translation start and stop sequences. This allows foreign DNA to be transcribed and translated in the respective host. These vectors are used for in-vitro proteins production, to test the strength of promoters and enhancers.

#### E. Transferring the recombinant DNA fragment into a host (bacteria, animal cells, plant cells)

##### Bacteria

- i. **Transformation:** Bacteria can uptake DNA from the medium in which it survives.
- ii. **In vitro packaging.** Cloned DNA is packed onto a virus (lambda vector) so that as it infects the bacteria, it will pass on the gene of interest along with its genetic material.

##### Animal cells:-

- i. **Through animal virus as vector:** Many such disarmed animal viruses (like retroviruses and adenovirus) serve as viral vector to introduce foreign DNA into mammalian cells.
- ii. **Electroporation:-** where cell membrane is made more permeable by  $Ca^{+2}$  ions electric shocks
- iii. **Biolistics:-** DNA is coupled to a nano-particle of an inert solid (gold) which is then shot directly into the target cell nucleus by a gene gun.
- iv. **Microinjection** - The injection of DNA directly into the nucleus using a very fine needle

##### Plant cells

- i. **Electroporation**
- ii. **Biolistics**
- iii. **Microinjection** (as in animal cells)
- iv. **T-DNA:** Agrobacterium tumefaciens has plasmid that causes tumor in plants. The T-DNA is disarmed by removing the gene to formation hormone for initiation of tumor. But its gene for virility is retained that helps in infecting the recipient.

#### F. Industrial production:-

Culturing the host cells in a medium at large scale:  
A bioreactor may refer to stainless steel container having suitable system to support a biologically active environment meant to grow cells in large quantities. This process can either be aerobic or anaerobic. Under optimum conditions the microorganisms / cells are allowed to propagate and undergo metabolic activities resulting in production of desired product.

Components of a bioreactor:

- i. Stainless steel container
- ii. Gas inlet /exit for air (oxygen, nitrogen, carbon dioxide)
- iii. Flow meters
- iv. Temperature monitor
- v. pH monitor
- vi. DO level
- vii. Agitation with speed control for circulation of medium

The chemical compounds synthesised by these cultured cells, such as therapeutic agents, can be extracted easily from the cell biomass.

#### H. Downstream processing

refers to the separation, recovery and purification of biosynthetic products, particularly pharmaceuticals, from natural sources such as animal or plant tissue or fermentation broth, including the recycling of salvageable components and the proper treatment and disposal of waste. It is an essential step in the manufacture of pharmaceuticals such as antibiotics, hormones (e.g. insulin and human growth hormone), antibodies and vaccines; antibodies and enzymes used in diagnostics; industrial enzymes; and natural fragrance and flavor compounds.

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**CHAPTER - 11**  
**BIOTCHNOLOGY PRINCIPLES & PROCESSES**  
**PRACTICE MCQ's**

1. The following properties of plasmid make it a good tool in genetic research:
  - i. Segment of chromosome
  - ii. Extra chromosome DNA
  - iii. Extra chromosome RNA
  - iv. Self replicating
  - a. Only (i) and (ii) are correct.
  - b. Only (ii) and (iii) are correct.
  - c. Only (i), (ii), (iii) and (iv) are correct.
  - d. Only (ii) & (iv) are correct.
2. An enzyme that can recognize ....GAATTA... sequence is called:
  - a. Exonuclease
  - b. Restriction Exonuclease
  - c. Restriction Endonuclease
  - d. Endonuclease
3. The cut made by EcoR1 is results in :
  - a. Sticky ends with cut after ..GA.. on each side
  - b. Blunt ends with cut after ..GA.. on each side
  - c. Sticky ends with cut between ..GA.. on each side
  - d. Blunt ends with cut between ..GA.. on each side
4. To extract the genetic material from a cell, the cell must be initially opened by:
  - i. Bacteria (a) Pectinase
  - ii. Animal cell (b) Cellulase
  - iii. Plant cell (c) Chitinase
  - iv. Fungus (d) Lysozyme
  - a. (i-a),(ii-b), (iii-c), (iv-d)
  - b. (i-b),(ii-c), (iii-d), (iv-a)
  - c. (i-d),(ii-a), (iii-b), (iv-c)
  - d. (i-d),(ii-a), (iii-c), (iv-b)
5. A palindrome is a:
  - a. Sequence of DNA with gene for resistance
  - b. Sequence of RNA with gene for resistance
  - c. Sequence of DNA within a gene for resistance
  - d. Sequence of DNA within any gene with same bases but in reversible arrangement
6. Transformants can be recognized by the :
  - a. Presence of gene of interest
  - b. Inability to survive in the presence of antibiotic
  - c. Ability to survive in the presence of antibiotic
  - d. Absence of gene of interest
7. The process of invitro amplification of DNA during PCR, requires the duplex to be opened by a foreign enzyme because:
  - a. It is easily available
  - b. Its repeat cycles are maximum in the living world
  - c. It can tolerate high temperatures of more than double the normal human range
  - d. It can tolerate high pH of more than double the normal human range
8. In a bioreactor, the role of motor is to:
  - a. Bring rotation for even distribution of foam
  - b. Bring rotation for even distribution of air
  - c. Bring rotation for even distribution of minerals
  - d. Bring rotation for even distribution of medium

**Assertion and Reason:**

- a. If both 'A' and 'R' are correct and 'R' is the correct explanation of the 'A'.

- b. If both 'A' and 'R' are correct and 'R' is not the correct explanation of the 'A'.
  - c. If 'A' is correct but 'R' is false.
  - d. If 'A' is false but 'R' is correct.
9. **Assertion:** Sterile air is always injected into the bioreactor from below.  
**Reason:** Sterile air bubbles through the medium upwards to evenly exchange gases.
10. **Assertion:** T-DNA is a good tool in DNA cloning.  
**Reason:** T-DNA is capable of initiating multiplication of host cells so as to increase the copies of genetically modified cell.

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## CHAPTER – 12

### BIOTECHNOLOGY AND ITS APPLICATION

- **Adenosine deaminase: ADA** is an enzyme necessary for the immune system. Its deficiency leads to prevention of lymphocyte proliferation hence immune deficiency.
- **Agrobacterium tumefaciens:** The bacterium which causes crown gall of dicot plants. It inserts its ‘Ti’ plasmid DNA into the host plant cell. The inserted DNA produces growth hormones which result in the uncontrolled mitosis resulting in tumor providing habitat for the bacteria. This is an example of natural genetic engineering. The ‘Ti’ plasmid can be used as a transformation vector.
- **Bioremediation:** Method used to recycle, treat waste, cleanup sites contaminated by industrial activities.
- **Bt (Bacillus thuringiensis):** A soil bacterium that produces insecticidal proteins. There are several different kinds of proteins produced by different strains of ‘Bt’, some are effective against larvae of moths and butterflies. Others are effective against larvae of beetles. The ‘Bt’ protein has been introduced into various crops as a built-in insecticide.
- **cDNA:** Complementary DNA to a particular RNA fragment produced by reverse transcription.
- **DNA cloning:** The production of a lineage of cells all of which contain one kind of DNA fragment (gene of interest).
- **Enzyme-Linked Immuno Sorbent Assay (ELISA):** It is a biochemical technique used to detect the presence of an antibody / protein in a given sample. ELISA is being used as a diagnostic tool in medicine.
- **Gene therapy:** The introduction of new genes into individuals to cure diseases or genetic abnormalities.
- **Genetically Modified Organism (GMO):** An organism with a functional foreign gene incorporated by using Recombinant DNA Technology. The foreign gene will be present in all of its progenies.
- **Recombinant DNA technology:** Biological techniques to combine DNA molecules from different sources into one single poly-nucleotide.
- **RNA interference:** (RNA-mediated interference or **RNAi**) is a mechanism for sequence specific suppression of gene expression by double-stranded RNA (dsRNA) either at transcription / translation stage (RISC complex).
- **T-DNA (transfer DNA, tumor-DNA).** The transforming region of DNA in the Ti plasmid of *Agrobacterium tumefaciens*

Biotechnology has applications in four major industrial areas:

- a. Crop production and agriculture (eg. transgenic plants / animals)
- b. Medicine (designing of organisms to produce antibiotics, hormones, gene therapy)
- c. Non food uses of crops (eg. biodegradable plastics, vegetable oil, biofuels)
- d. Environmental uses (eg. the mining industry in bioleaching and is used to recycle, treat waste, clean up sites contaminated by industrial activities - bioremediation).

Three critical research areas are:

1. To provide the best catalyst in the form of improved organism or pure enzyme.
2. To create optimal conditions through engineering for a catalyst to act.
3. To develop downstream processing technologies.

#### **A. Applications in Agriculture**

Three options that can be thought for increasing food production:

1. agro-chemical based agriculture
2. organic agriculture
3. genetically engineered crop-based agriculture ( through rDNA technology)

The introduction of recombinant DNA (rDNA) into plants and animals has enormous implications for agriculture. Some examples are as follows.

- i. **Bt cotton:** Bacteria *Bacillus thuringiensis* has a specific gene (Bt gene/cry gene) that produces a protein (**inactive protoxin**) with insecticidal qualities. The protoxin must be ingested so that in the alkaline medium of GI tract it is activated to show its effect. There are several Bt toxins and each one is specific to certain target insects. Crop plants have now been engineered to contain and

express the cry genes for Bt toxin (inactive). When a susceptible insect ingests the transgenic crop cultivar expressing the Bt gene, the Bt pro-toxin gets activated in gut in alkaline medium, binds to its gut wall and create pores that cause cell swelling and lysis leading to death.

- a. cryIAb: to controls corn borer.
  - b. cryIAb & cryIIAc : to control cotton bollworm.
- ii. **RNAi approach:** The **RNA interference** approach is helpful for subterranean pests. It is used to inhibit expression of a targeted essential gene of parasitic nematode gene. It helps in formation of plants having increased resistance to parasitic nematodes.
- a. Agrobacterium is used to introduce nematode specific genes into the host plant.
  - b. Gene expresses & produces both sense and antisense RNA in the host cell.
  - c. Being complementary to each other it forms double stranded RNA (ds RNA).
  - d. Initiated RNAi.
  - e. Prevents the translation of targeted mRNA critical for survival of the nematode.
  - f. Silences the mRNA of the nematode.
  - g. The parasite cannot survive in the transgenic host.
  - h. The plant gets protection from the nematode.
- iii. Genetically engineered plants retards senescence thereby increasing shelf life of fruit (storage & transportation losses reduced).
- iv. Herbicide tolerant crops help in reducing the amount of herbicide active ingredients used for weed management.
- v. Nutritional value may be enhanced by incorporating genes controlling protein, vitamins etc as per the need.
- vi. Enhanced efficiency of mineral usage may be attained.

**B. Applications in Medicine:** In medicine, modern biotechnology finds promising applications in:

- Gene therapy
- Drug production
- Genetic testing
- Design and produce drugs that are adapted to each person's genetic makeup.
- Mapping of human genes on chromosomes is now possible (Biotechnology has helped scientists in linking mutations / disease states to specific sites on chromosomes)

**Drug production:** Isolation of large quantities of pure protein:

Many natural products secreted by human body like insulin, GH, FSH, proteins are now available as recombinant products with efficiency similarity natural products.

**Insulin:** Previously the sole source was bovine and porcine insulin that is similar to human insulin but not exactly same. Many cases were reported by patients getting immune responses.

Chemically, active insulin is a small protein consists of two polypeptide chains (A-B), linked by disulfide bond. However, it is secreted as proinsulin with 'C-peptide' in between 'A & B' chains.

- In 1983, Eli Lilly an American company, isolated the genes for chain (A & B) using r-DNA technology.
- The genes were introduced into separate plasmids and multiplied in separate E. coli cells.
- Using downstream processing, the polypeptide chains A & B were obtained.
- Both the chains were joined by disulphide linkage to get mature functional insulin.

Similarly, the gene for human insulin has been added to yeast. The recombinant yeast upon culturing produces large quantities of insulin. The final product is called Humulin which is chemically identical to human insulin, so have no adverse reactions. Banana trees and tomato plants have also been genetically engineered to produce vaccines in their fruit.

**Gene therapy:-**

Gene therapy uses normal genes to supplement or replace defective genes or to re-establish normal functioning such as immunity. It can be used to target

There are basically two ways of implementing a gene therapy treatment:

- a. In-vitro (outside the body):- Cells from the patient's blood or bone marrow are removed and grown under laboratory condition. Virus vector carrying the desired gene infects the cell in



the culture medium. The desired gene becomes part of the DNA of the cells by transduction. The cells are allowed to grow in the laboratory before being re-injected to the patient.

- b. In vivo (inside the body):- Engineered virus as vectors are used to deliver the desired gene to cells in the patient's body.

The virus vectors are engineered by reducing their pathogenicity but maintaining the property to infect along with insertion of gene of interest.

**Adenosine deaminase deficiency (ADA deficiency):-** It is an inherited immunodeficiency syndrome accounting for about 25% of all cases of severe combined immunodeficiency (SCID). Adenosine deaminase (ADA) is an enzyme required to break purine (adenine). Lack of ADA hampers lymphocyte proliferation and hence the immune system gets compromised.

The first gene therapy to combat this disease was performed by Dr. W. French Anderson on a 4yr old girl, Ashanti DeSilva, in 14 September 1990 at the National Institute of Health, Bethesda, Maryland, U.S.A. The therapy performed was the first successful case of gene therapy.

Treatment of ADA deficiency:

- a. Temporary process:
  - i. Lymphocytes from bone marrow are cultured in medium.
  - ii. Viral vector is used to introduce ADA cDNA into host lymphocyte cell.
  - iii. Genetically engineered lymphocytes are infused into bone marrow for functioning.
  - iv. Drawback:- Lymphocytes have limited life so the process needs repetition.
- b. Stem Cell Therapy:
  - i. Functional gene is inserted into the stem cells in the early embryonic state for permanent cure.
  - ii. Still under experimental stage.

**Molecular diagnosis:** Early diagnosis and understanding of a disease is very essential. There are two methods for detection.

- i. Conventional :- Testing serum, urine which do not come under early diagnosis.
- ii. Non-conventional:- R-DNA technology involving PCR, autoradiography and ELISA methods can detect a particular gene or the protein even before the disease is noticeable. It can change the course of action.
  - a. PCR is used to detect low concentration of a genetic material of any cell by multiplying/ amplifying the DNA in a PCR machine.
  - b. ELISA is based on the principle of antigen-antibody interaction. Infection by a pathogen can be detected by the presence of antigens.

Modern biotechnology is increasingly being applied for novel uses other than food.

- i. Biodegradable plastics
- ii. Bio-fuels as a substitute for petro-chemicals
- iii. Enhancing plant resistance: Gene DBF2 was inserted into tomato and tobacco cells to make them withstand environmental stresses like salt, drought, cold and heat.

**Transgenic animals:** Animals with manipulated DNA/genes and express them are called transgenic animals.

**Applications:-**

- i. Normal physiology and development: Transgenic animals can be used to study the normal role of genes and their products.
- ii. Study of Disease: Such genetically modified animals are designed to enhance our knowledge about the development of disease. They are specifically made to serve as models for human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and alzheimer's disease.
- iii. Biological products: Useful biological products like some proteins, drugs can be prepared by r-DNA technology from transgenic animal.
  - a. Rosie, the first transgenic cow (1997) produced human protein enriched milk (2.4 grams / litre). It contained human alpha-lactalbumin, so better than normal cow's milk.

- b. Production of human  $\alpha$ -1-antitrypsin to treat emphysema.
- c. Similar attempts to treat PKU and cystic fibrosis.
- iv. Vaccine safety: Transgenic mice have been produced for testing a drug / vaccine. If successful on mice, then tests are carried on monkeys before human trials.
- v. Chemical safety testing: Toxicity of drugs can be tested in transgenic animals and the effects are observed. Such animals are made sensitive to the concerned toxin and then the effect of toxin is studied for better understanding.

**Ethical issues:** Transgenic biotechnology presents an exciting range of possibilities, from feeding the hungry to preventing and treating diseases. However, these promises are not without potential dangers. So lot of regulations are required.

GEAC (Genetic Engineering Approval Committee) setup by Indian Govt. is an organization to take decisions regarding the validity of GM research and the safety of its introduction.

There is persistent uproar among the local populations against the multinational companies who manipulate & take knowledge and products of biodiversity away from the people through patents and Intellectual Property Rights (IPRs).

A patent is an exclusive right to make, sell and distribute the patented product. Patents on biodiversity imply that corporations which own patents, get exclusive right to the production and distribution of seeds, livestock and medicine. This establishes monopolies on food and health, makes it illegal for farmers to save and exchange seed, and prevents decentralized economies for the production of food and medicine.

**Bio-piracy:** Bio-piracy is a type of theft of our indigenous knowledge regarding bio-diversity and its value by anyone. The multinational companies steal a country's biological and intellectual wealth without seeking permission from the local communities who actually derived and developed this knowledge. Later the company gets the patent regarding the knowledge.

**Case of Basmati rice:** Basmati rice is distinct for its unique aroma and flavour. There is reference to Basmati in ancient texts, folklore and poetry, as it has been grown for centuries. Nearly 27 distinctly documented varieties of Basmati are grown in India. In 1997 Rice Tec, a US based company got patent rights on Basmati rice and grains, through the US Patent and Trademark Office. This allows Rice Tech. Inc to sell a new variety of Basmati, in the US and abroad. But actually this new variety of Basmati has been derived by crossing Indian Basmati with semi-dwarf American variety and thereby falsely claiming as an invention/novelty. Indian government won a legal battle against the patent. Other patents that were opposed were on turmeric and neem products.

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**CHAPTER - 12**  
**BIOTECHNOLOGY AND ITS APPLICATION**  
**PRACTICE MCQ's**

1. GMO's may have the property of:
  - i. Tolerance to abiotic factors
  - ii. Enhanced shelf life
  - iii. Decreased pest attack
  - iv. Enhanced vitamin A content
  - a. Only (i) and (ii) are correct.
  - b. Only (ii) and (iii) are correct.
  - c. Only (i), (ii), (iii) and (iv) are correct.
  - d. Only (ii) & (iv) are correct.
2. The bacteria *Bacillus thuringiensis* is not killed by its toxin because:
  - a. Bacteria is resistant to the toxin.
  - b. Toxin produced is immature
  - c. Toxin produced is inactive
  - d. Bacteria encloses toxin in a protein coat
3. The transgenic bacteria is an organism that:
  - a. Receives a gene of interest
  - b. Donates a gene of interest
  - c. Undergo mutation for gene alteration
  - d. Undergoes conjugation for gene introduction
4. The long lasting cure to ADA deficiency that impair the immune system badly is:
  - a. Vaccination for ADA
  - b. Blood transfusion
  - c. Lymphocyte infusion
  - d. ADA cDNA incorporation by rDNA technology
5. Bt cotton is resistant to cotton bollworm because :
  - a. Cry gene in bacteria produces cry protein in bacteria
  - b. Cry gene in bacteria produces cry protein in host plant
  - c. cry gene in host plant produces Cry protein in host plant
  - d. Cry gene in host plant produces Cry protein in host plant
6. Transgenic animals form an important part in the research in genetics to understand:
  - i. Normal physiology of the gene
  - ii. The onset of a disease
  - iii. To obtain a product that is difficult to manufacture mechanically
  - iv. Safety concerns of a vaccine
  - v. (i) and (ii)
  - vi. (i) and (iv)
  - vii. (i), (ii) and (iv)
  - viii. (i), (ii), (iii) and (iv)
7. GEAC stands for:
  - a. Global Energy Allocation Committee
  - b. Global Engineering Approval Committee
  - c. Genetic Engineering Approval Committee
  - d. Global Engineering Allocation Committee
8. The active functional insulin consists of:
  - a. Chain A and Chain C glucose polymer linked with glycosidic bonds
  - b. Chain A and Chain B polypeptide linked with glycosidic bonds
  - c. Chain A and Chain B polypeptide linked with disulphide bonds
  - d. Chain A and Chain B polypeptide linked with phosphodiester bonds

**Assertion and Reason:**

- a. If both 'A' and 'R' are correct and 'R' is the correct explanation of the 'A'.
- b. If both 'A' and 'R' are correct and 'R' is not the correct explanation of the 'A'.

- c. If 'A' is correct but 'R' is false.  
d. If 'A' is false but 'R' is correct.
9. **Assertion:** Basmati rice is an aromatic premium variety of rice in India with 27 Indian cultivars.  
**Reason:** Patent of basmati by Monsanto has been legally opposed by India.
10. **Assertion:** iRNA is a way to prevent the expression of genes at translational level.  
**Reason:** It results in formation of dsRNA with sense and anti-sense strands resulting in preventing the expression.

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**CHAPTER – 13**  
**ORGANISMS & POPULATION**

- **Ecology:-** Study of interaction between living organisms & their environment.
- **Species:-** A group of organisms having capacity to interbreed naturally.
- **Population:-** A group of naturally interbreeding organisms living in a specific area for specific time.
- **Community:-** Different populations, living together, in a specific area during specific time.
- **Ecosystem:-** The sum total of the biotic & abiotic components of a particular geographical area.
- **Biome:-** A very large unit, consisting of a major vegetation type and associated fauna found in a specific climatic zone.
- **Environment:-** Sum total of physio-bio-chemical factors affecting an organism.
- **Micro-climate:-** Climatic conditions which are present in the immediate surroundings of various organisms.
- **Habitat:-** The place where an organism lives.
- **Permafrost:-** Extreme cold and snowy habitat with year round .
- **Homeostasis:-** Maintenance of relative constant internal environment despite varying external factors.
- **Ecological Niche:-** Specific area within a habitat, more suitable to one specific organism.
- **Range of tolerance:-** The range between maximum and minimum limits of a factor. It determines the existence and abundance of an organism.
- **Acclimatization:-** The gradual adjustment of body to slow environmental changes. If tolerance limit shifts beyond optimum range then either organisms adopt the new change or shift to other place or come to a stationary growth phase.
- **Adaptations:-** Surviving successfully under a set of environmental conditions is called adaptation.
- **Phenotype:-** External appearance of an organism, a result of interaction of genotype & environment.
- **Natality:-** Increase in number by birth in a population. Number of live Births/1000 Births in a specific time. It causes +ve growth in population.
- **Mortality:-** Decrease in population by death. No. of deaths/1000 individuals of population per year. It causes –ve growth.
- **Immigration:-** Incoming of members of a species from another habitat. It is +ve growth.
- **Emigration:-** Outgoing of members of a population to another habitat. It is -ve growth.
- **Carrying capacity:-** The number of individuals that can efficiently survive in a habitat based on the prevalent environmental resources.
- **Ecological levels of organization:-** Organism level, Population, Community, Biome level.
- **Physiological ecology:-** It is the ecology at the organismic level and studies the adaptations of an organism to the surroundings concerning survival and reproduction.

It involves a lot of interaction between biotic (all living components) and abiotic (physio-chemical components).

e.g.:- The physio-chemistry of soil is influenced by revolution of earth around sun, it causes seasons which determine the distribution of biota (flora-fauna) making large scale eco-systems called biomes.

**HABITAT:-** A specific inter-related system of biotic and abiotic factors which result in efficient survival and reproduction of an organism. Life have adapted to a wide variety of habitats, from depths of ocean to the heights of mountains, from scorching heat of deserts, geysers and thermal vents to the glaciers, from anaerobic environment of intestine to aerobic environment of springs.

**Components of ecosystem:-**

- Abiotic / Physio-chemical:- Temperature, water, light, wind
- Biotic:- Pathogens, parasites, predators, competitors

### Major abiotic factors:

- a) **Temperature**:- The average temperature varies with latitude / longitude and seasons of an area. It ranges from  $>50^{\circ}\text{C}$  at the equator and deserts to  $<-50^{\circ}\text{C}$  at poles. In sulphur springs and hydrothermal vents it may rise up to  $100^{\circ}\text{C}$ .

However organisms adapt to a specific range of temperature only. So, the polar bear cannot be found in plains or mangoes cannot be in temperate zones. This is because temp. influences enzyme kinetics and hence metabolism. Based on this organisms are grouped into two:

- i) Eury-thermal:- Can tolerate wide range of temperatures for survival (few organisms).
- ii) Steno-thermal:- Can tolerate low range of temperatures for survival (Maximum number).

- b) **Hydrosphere/Hydrological Cycle (Water)**:- Life originated in water and is unsustainable without it. The distribution of biota and the adaptations required thereof are determined by the presence of physiologically available water.

There is no shortage of water in marine habitat but still the distribution of biota depends upon the composition and pH of water available. Salt is a major component here.

Inland water	:	05 % ( parts per thousand )
Sea water	:	30-35 %
Hyper saline lagoons	:	100 %


Based upon salinity organisms are divided into two groups –

- i. Eury-haline: Can tolerate wide range of salinity.
- ii. Steno-haline: Restricted to a narrow range of salinity.

Change in salinity causes osmotic imbalances. So organisms surviving there must have suitable metabolic adjustments otherwise the organism will not be able to survive.

e.g. :- A fresh water fish in sea water and vice a versa.

- c) **Light** - It is the life line for organisms on earth. Sun, the sole energy source.

Land Plants & Light		Quality - Wave length	{Photosynthesis, Flowering}
		Intensity - Energy	{Transpiration}
		Duration - Day length	{Seasonal activities}

In animals the duration / seasonal variations of light (Photoperiod) decides the time to feed, reproduce and mate. Light quantity (intensity and duration) influences the temperature and water.

- d) **Soil** - The distribution of biota on the soil depends upon:-

- i) Climate – Weathering of rocks
- ii) Type of soil – Transported / Sedimentary soil.
- iii) Physical aspects – Grain size, aggregation (water holding / percolation capacity)
- iv) Chemistry – pH, Minerals.
- v) Topography – Distribution of flora  $\longrightarrow$  Distribution of fauna.
- vi) Aquatic soil – Distribution of benthic organisms.

**Organic Matter**- Humus/Detritus is dark brown amorphous colloidal layer. It harbors organisms like detritus feeders, fungi, bacteria.

**Effects of Minerals on Biota** - Living beings have a range of tolerance. Any factor can become the rate limiting factor as depicted below:

- i. Low temp - Plant growth reduced
- ii. Less water- Life impaired in deserts
- iii. Low phosphate ion- Reduced growth of phytoplankton

Desert / Xerophytic Adaptations (Physical factors):- High temp, low water, high salinity.

### RESPONSE TO ABIOTIC ENVIRONMENT:

Organisms have evolved to adjust to a specific range of environmental factors so as to maintain their metabolism at a maximum efficiency rate. Some organisms maintain a relative constant internal environment (homeostasis). A state of maxima is attained by-

- a) Physiological level - Regulators / Conformers
- b) Behavioral level - Migrate / Suspend / Diapause.

**a-1) Regulators** – Plants do not have such systems but animals maintain constancy by:-

- i) Temperature – Thermo-regulation
- ii) Osmotic conc.- Osmo-regulation.

Criterion	Season	Response	Effect
Thermo-regulation	Summer	Sweating	Water comes out of body, evaporates and takes away heat
	Winter	Shivering	Muscle contractions, vibrations, heat generation

**a-2) Conformers:-** 99 % of animals and plants cannot undergo thermo / Osmo-regulation. Thermo-regulation is energetically expensive (heat loss/gain is based on surface area/volume ratio of body).

e.g.:- Smaller animals (tree shrews / humming birds) have more surface area/volume ratio, so heat is lost quickly. This is the reason that smaller animals are not found in polar environments.

Some animals regulate within a specific range only, beyond which they become conformers.

**b) Behavioral adaptations:-** Short duration stress conditions force the animal to either migrate, suspend its metabolism or suspended state of division.

i. **Migration:-** Avoid stress conditions till they are over.

e.g.- Migration of Siberian birds to Bharatpur bird sanctuary in winters.

ii. **Suspend:-** Microbes produce thick walled spores, plants produce seeds that are in a state of dormancy (reduced metabolism) till the next growing season.

In animals where migration is not possible they evade in time.

e.g.:- Hibernation - Polar Bear

Aestivation - Frogs

Diapause - Zoo-plankton (Suspended state of development).

## ADAPTATIONS

Any attribute (morpho-physio-behaviorial) that enables an organism to survive and reproduce in a habitat is called as adaptation.

Many adaptations have become a part of evolutionary process (fixed in genetics).

e.g. Xerophytic condition (Desert):- Kangaroo rat- In the absence of water, it can use its metabolic water (respiratory end product) and atmospheric humidity.

## TERRESTRIAL ADAPTATIONS BASED ON PHYSICAL FACTORS:-

### 1. Light -

i. **Heliophytes:-**Tolerate wide range of temp./light intensity, have high optima for Photosynthesis and have high respiration rate (e.g.- Cactus).

ii. **Sciophytes:-** Shade adapted plants, can tolerate narrow range of temperature variations, low photosynthesis & low respiration rates (e.g. Ferns).

### 2. Water Scarcity

i. **Ephemerals:-** Skip dry conditions for growth, complete their life cycle within a short growing period only & seeds survive in dry season.

ii. **Deep-rooted plants:-** Roots deep to reach water table (eg. Prosopis).

iii. **Deciduous leaf plants:-** Leaf fall during dry season to cut transpiration (e.g. Acacia)

iv. **Sunken stomata:-** Reduce transpiration [Nerium, Pine]

v. **Leathery leaf/Waxy coating:-** Reduce transpiration.

vi. **Succulence:-** Store water in spongy tissue as reserve source of hydration.

**C4-Adaptation-** Such plants have low water requirement.

**CAM plants-** Close stomata during day hence reduce transpiration & photorespiration.

## AQUATIC ADAPTATIONS & PHYSICAL FACTORS IN AQUATIC ENVIRONMENT:-

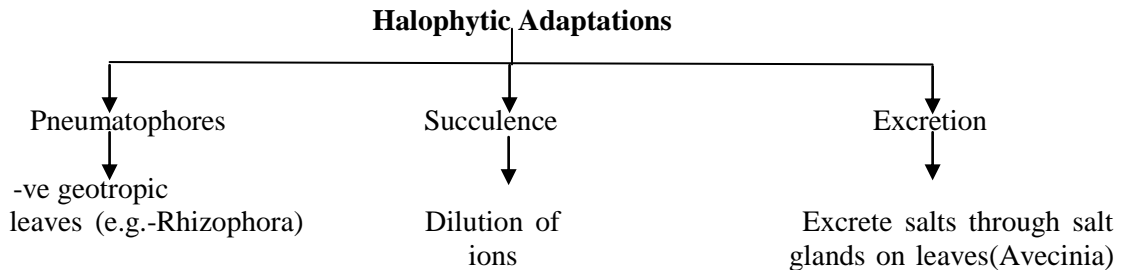
**Excess of Water-** Develop aerenchyma/ air cavity for upward thrust.

**Oxygen Deficiency-** Air inside aerenchyma compensates reduced DO (deficiency of O<sub>2</sub>) in water.

## **HYDROPHYTIC ADAPTATIONS:-**

- i. **Free Floating** : Large surface area of leaves helps in buoyancy.
- ii. **Desiccation** : Waxy coating/Cuticle/Mucous prevent desiccation.
- iii. **Torn apart** : Comb like leaves offer least resistance to flow of water.

**Physical Factors Saline Environment** - High salt concentration /Physiological Dryness  
-Low Soil Oxygen Conc.



Dunaliella- Hypersaline Lake :- Accumulate glycerol for osmolarity.

**Oligotrophic Soils-** Contain low amount of nutrients e.g. soils of tropical rain forests

**-ve factors**

**Effects**

1. Intense Weathering → Poor nutrients
2. High rate of Leaching → Retention Capacity reduced

**Aquatic System & Light:** Light is directly proportional to temp. & inversely proportional to depth of water. Hence majority of flora & fauna is found in surface waters.

### ANIMAL ADAPTATIONS

Animals like mammals, habitant of cold environmental conditions, adapt in different modes for survival:-

a. **Morphological adaptations:-**

- i. Allen's Rule:- Short ears / limbs to reduce heat loss.  
Thick fat layer / blubber to reduce heat loss.

b. **Physiological adaptations:-** In humans:-

- i. At high altitude (low O<sub>2</sub> conc.) causes – Nausea, fatigue, palpitation.  
Body gradually adjusts (acclimatize) by:
  - Releasing more RBC's
  - Decreasing binding capacity of Hb to O<sub>2</sub>
  - Increasing breathing rate.
- ii. Temperature adjustments:
  - Hot springs / Hydrothermal vents – Archebacteria
  - Sub zero level, prevent fluids from freezing by forming ice nucleating proteins / glycerol (Arctic fish).

- iii. Pressure adjustments-Great depths of ocean-Body flat-Some invertebrates and fishes.

c. **Behavioral adaptations:-**Cold condition-Bask in sun to increase body temperature (Lizard)

- Hot condition- Move to shady places

### POPULATION ATTRIBUTES

Population is a naturally interbreeding group of similar organisms inhabitants of a particular space and during specific time. This definition pertains to sexually reproducing organisms. However from ecological context asexually reproducing organisms also constitute populations. Natural selection operates at population level.

Population ecology → Ecology → Population genetics → Evolution

- a. **Rate of change in numbers** - Individual organisms undergo birth / death



Population have Birth Rate / Death Rate i.e. change in number per unit population.  
e.g. If increase is 10 per 20 in an area, so birth rate becomes 0.5 organisms per person.

- b. **Sex Ratio:-** It is a population characteristics and not individual. An individual may be male or female but population represents sex ratio i.e. total females per 1000 males.  
e.g. Humans – 880 females to 1000 males.
- c. **Age distribution:-** Percentage of individuals of a given age at a given time. It is represented by age pyramids.
- Pre-reproductive System: Infancy (Birth-1year);
  - Childhood (1-13 Years);
  - Adolescence (13-18 Years)
  - Reproductive (18-45 Years)
  - Post Reproductive (45 yrs. onwards)

In a population pyramid, a wider base (childhood) represents growing population and vice a versa.

The physical number of individuals of a species in a particular area is called population density (N), it depends upon the size of organism.

e.g. 'N' for Siberian crane in Bharatpur Sanctuary < 10  
'N' for bacteria in a petridish > 10<sup>6</sup>

In certain situations, population density is measured in terms of biomass.

e.g. 100 Parthenium plants in an area with one Banyan tree. Considering numbers Parthenium is definitely 100 times more but the banyan tree have more % cover and biomass.

### POPULATION GROWTH

Population is a dynamic entity (keeps changing). Growth is predicted based upon certain parameters- Natality(B), Mortality(M), Immigration(I), Emigration( E) .

Population density  $N_{t+1} = N_t + [(B + I) - (D + E)]$

$N_t$  = Initial population

$N_{t+1}$  = Population at time (t+1)

**GROWTH MODELS:-** The logistic representation of growth in a population of an area.

- a) **Exponential growth:-** When food and space is unlimited (no negative pressure) in a particular area, the concerning population tends to attain maximum growth potential.

N = Size of population

$$dN / dt = (b - d) X * N$$

t = Time frame

$$\text{If } (b - d) = r$$

b = Per capita birth rate

$$dN / dt = rN$$

d = Per capita death rate

$$N_t = N_0 e^{rt}$$

The Darwin's concept highlighting that each species has exponential growth rate is similar to above calculations.

- b) **Logistic growth:-** Since the natural resources may become limited at any time, so negative checks are always operational. This results in competition and hence only the fittest survives and reproduce resulting in a specific number of individuals of a population in an area. It determines the Carrying Capacity (K) of a habitat also called **Verhulst – Pearl Logistic Growth.**

Such a population shows four phases of growth –

Lag phase → Log / acceleration → Deceleration → Asymptote

When the population density reaches the limit of carrying capacity it is represented as

$$dN / dt = r N \{ 1 - N / K \}$$

### LIFE HISTORY VARIATIONS

Darwinian fitness (high 'r' value):-Every population tries to evolve to its maximum reproductive fitness under a particular set of pressures. Here 'r' = (b-d).

e.g. Bamboo and Pacific Salmon Fish – Breed once per life time.

- Mammals and birds - Breed many times per life time.
  - Oysters, Pelagic fishes - Produce large number of small sized offspring's.
  - Mammals and birds - Produce small number of large sized offspring's
- So, the strategy for reproduction suitable for a species depends upon its evolution in the presence of a set of constraints ( both a biotic and biotic ) .

**POPULATION INTERACTIONS:-**

No organism can live in isolation. It must interact with a biotic and biotic factors for propagation.

Interactions are of two types:-

- i. **Intra-specific**:- Between organisms of same species for same resources (more intense).  
E.g. : Sharing of food, space and mate.
  - ii. **Inter- specific**:- Between organisms of two different species for food and space.
    - a. Positive to both species ( Mutualism)
    - b. Positive to one, negative to other ( Predation, Parasitism)
    - c. Positive to one, no effect to other ( Commensalism)
- a) Predation :** One is benefited but the other one is harmed. Ecologically it is a way to transfer energy- food chain (so it maintains life on this planet ).
- Carnivory:- A tiger eating a deer.
  - Herbivory:-A deer eating grass (ecologically it is predation).

Benefits:-

- i. Keeps the prey population in control, otherwise ecological instability arises.  
e.g. If tiger are removed what will happen to the deer population.  
If deer are removed what will happen to the plant population.
- ii. Helps in maintaining species diversity.
- iii. Reduces intensity of competition.  
e.g. Removal of star fish from specific inter-tidal zone, resulted in the extinction of ten species of invertebrates (because star fish feeds on the predators of those invertebrates)

Predators are intelligent / prudent – Predation is done in a balanced manner.

Prey animals are not far behind, they adapt to escape predation.

**Strategies developed by prey animals to evade predation –**

- i) **Cryptic colouration (Camouflage)**:-Weaker species develops the colour pattern of stronger/dangerous/dis-tasteful species.  
e.g.:-Monarch butterfly (distasteful) being copied by Viceroy butterfly (food for some birds) for colour patterns.
  - ii) **Distasteful chemicals**:-Monarch butterfly becomes distasteful as its caterpillar feeds on a distasteful / poisonous weed .  
Plants in order to evade predation develop -  
Morphological- Thorns for defense against grazing (Acacia)  
Bio-chemicals - Make the feeder ill / die (Cardiac glycosides, Nicotine, Caffeine, Quinine, Strychnine, Opium)
- b) Competition:** Principles given by Darwin (struggle for existence and survival of fittest) are fully applicable to competition.
- It is of following types-
- i) **Intra-specific**:- Members of one species for all types of resources.
  - ii) **Inter-specific**:- Closely related species for same resource  
e.g. Tiger → Goat ← Leopard (Totally unrelated species)  
e.g. Visiting → Zooplankton ← Native fish
  - iii) **Interference Competition**:-Resources are enormous, still the feeding efficiency of one species is reduced due to the inhibitory presence of the other one.
  - iv) **Competitive exclusion principle (Gause)**:- Resources being limited, two closely related competing species cannot co-exist indefinitely. The inferior one will be eliminated.

MacArthur -Species adjust to it by **resource partitioning (co-existence)** i.e. develop behavioral differences.

e.g. Different times of feeding to avoid competition.

v) **Competitive release:-** Removal of competitively superior species will result in expansion (population increase) of competitively inferior species.  
e.g. Connel's experiment ( larger Barnacles dominating smaller ones)

c) **Parasitism:-** A smaller organism gaining free lodging or food from the bigger one, which gets harmed.

They are of two types – Ecto-parasites, Endo-parasites.

Parasites may be host specific – host and parasite **Co-Evolve** (if host evolves some mechanism for resistance, the parasite develops counter measures.

Adaptations of parasites:-

i. If present in intestine:

- Loss of unnecessary sense organs
- Presence of suckers / adhesive discs
- Loss of digestive system
- High reproductive capacity( for successful survival )

ii. Some parasites have more than one host.

**Ecto- parasites:-** Host marine fish with parasite called copepods.

S.No.	Parasite	Host suffering damaged	Intermediate host not affected
1	Liver fluke	Human- liver tissue	Snail and fish
2	Plasmodium	Human – RBC's	Female Anopheles mosquito

Host trees / shrubs with parasite cuscuta.

**Brood parasites** (nest parasite):- Koel lays its eggs in the nest of crow.

Evolution has occurred towards matching the size and colour of eggs of both species.

d) **Commensalism:-** One species is benefited but the other one is not affected.

e.g. Orchids (epiphytes ) on trees-Orchids gets light, trees are not affected

Barnacles on the body of whale – Barnacles get food and transportation.

Cattle Egret & Cattle – Egret gets food from the disturbed grass.

e) **Mutualism :** Both the species gets benefited.

e.g. Lichens - (Mycobiont) fungal partner forms body and absorbs minerals / water.

- (Phycobiont) Cyanobacterial partner photosynthesize and both share their resources.

Pollinators & plants:- (Co-Evolution) one gets nectar the other gets reproductive security.

f) **Cheaters (Deceiving other) :** One getting benefit without giving in return.

i) Obtain nectar without pollinating the flower.

ii) Ensure pollination without giving nectar – Pseudo-copulation.

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**CHAPTER - 13**  
**ORGANISMS & POPULATION**  
**PRACTICE MCQ's**

1. A biome with mean values of annual rainfall and temperature to be <50mm & +15 would represent:
  - a. Alpine forest
  - b. Desert
  - c. Tropical deciduous forest
  - d. Grassland
2. The behavior of an animal in hibernation & aestivation respectively is:
  - a. Sleep during day & night respectively.
  - b. Sleep during summer & winter respectively.
  - c. Sleep during winter & summer respectively.
  - d. Sleep during & winter respectively.
3. Conformers are the life forms that:
  - a. Adjust body's metabolism in accordance with external environment
  - b. Adjust body's metabolism in accordance with the internal environment
  - c. Maintains body's metabolism at a constancy irrespective of external environment
  - d. Have no effect of either internal or external environment
4. As one explores the nature while traveling along the country side, one often notices a white coloured bird on the back of cattlegrazing in the field. This is a case of :
  - a. Ectoparasitism
  - b. Mutualism
  - c. Amensalism
  - d. Commensalism
5. The terms phycobiont and the mycobiont are used in reference to:
  - a. Fungal and algal partner in the lichens
  - b. Cynobacterial and fungal partners in the lichens
  - c. Algal and fungal partners in the lichens
  - d. Cynobacterial and algal partners in the lichens
6. The overall growth in the population of an area is based on:
  - i. Natality
  - ii. Mortality
  - iii. Immigration
  - iv. Emigration
  - a. (i) and (ii)
  - b. (ii) and (iv)
  - c. (i) and (iii)
  - d. (ii) and (iii)
7. A population pyramid with base representing pre-reproductive phase shorter than reproductive phase is a classic example of population :
  - a. Growth
  - b. Exponential growth
  - c. Decline
  - d. Stable
8. Lizards are cold blooded animals, still they manage to survive both in hot and cold environmental conditions where mammals are more comfortable. The reason is:
  - a. Morphological adaptations only
  - b. Behavioral adaptations
  - c. Physiological adaptations only
  - d. Morphological and physiological adaptations jointly

**Assertion and Reason:**

- a. If both 'A' and 'R' are correct and 'R' is the correct explanation of the 'A'.
  - b. If both 'A' and 'R' are correct and 'R' is not the correct explanation of the 'A'.
  - c. If 'A' is correct but 'R' is false.
  - d. If 'A' is false but 'R' is correct.
9. **Assertion:** Phytophagous life forms are predators of crops hence they are a menace.  
**Reason:** Phytophagous life forms feed on plant or its parts thereby reducing the profit of the farmer.
10. **Assertion:** Each organism has a specific gender leaving aside some cases of gender neutrality.  
**Reason:** Gender is an attribute of population.

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## CHAPTER – 15 BIODIVERSITY & CONSERVATION

- **Biodiversity:-** It refers to the totality of genes, species and ecosystem of a region.
- **Genetic Diversity:-** Variation of genes within a species.
- **Speciation:-** Evolution of new species based on genetic variations.
- **Species Diversity:-** Variety of species per unit area per unit time.
- **Species Richness:-** Number of species per unit area per unit time.
- **Alien Species or Exotic Species:-** New species entering into a geographical region.
- **Endemism:-** Species confined to a region and not found anywhere else.
- **Natural Extinction:-** Loss of species which occurred naturally in the geographical past due to change in environment.
- **Mass Extinction:-** Complete elimination of large number of species from a geographical area due to environmental catastrophic disturbances.
- **Extinct Species:-** A taxon is extinct in the wild when there is no reasonable doubt that the last individual has died.
- **Endangered Species:-** A taxon is endangered when it is facing a very high risk of extinction in the wild in near future.
- **Vulnerable:-** A taxon is vulnerable when it is not endangered but is facing a high risk of extinction in the wild in the near future.
- **Bioprospecting:-** Exploring molecular, genetic and species level diversity for products of economic importance.
- **Wild Life:-** Naturally occurring species of animals, plants and micro organism, which are not cultivated or domesticated.
- **National Park:-** A protected area, aimed for the betterment of wildlife, where human activities are not permitted.
- **Sanctuary:-** A protected area for conservation of animals only, where certain human activities such as harvesting of timber, collection of minor forest products are permitted.
- **Biosphere Reserves:-** A reserved area for multiple use of land but having many zones.
- **Sacred Forest/Groves:-** Tracts of forest where the trees and wild life are given total protection by tribal communities due to religious sanctity accorded to them.
- **Cryo-preservation:-** In vitro conservation in liquid nitrogen at  $-196^{\circ}\text{C}$ . It is useful for conserving vegetatively propagated crops.
- **Hot Spots:-** Regions with high level of species richness and high degree of endemism of plants and animal life on earth. They are the most threatened reservoirs of life on earth.
- **Ex-situ Conservation:-** Conservation of threatened plants and animals in special setting like zoological garden, botanical garden etc.
- **In-situ Conservation:-** Conservation of plants and animals in nature (conserve whole ecosystem) by establishing national park, biosphere reserves etc.
- **IUCN:** International Union for Conservation of Nature and Natural Resources.

**Biodiversity:-** Total diversity (heterogeneity) exists from macromolecule within the cell to biomes. i.e. totality of genes, species and ecosystem of a region. This term is popularized by Edward Wilson to describe the combined diversity at all levels of biological organization.

### 1. Level of Biodiversity-

- a. **Genetic Diversity:** Variation of genes within species over its distributional range.  
e.g.:- Nearly 50,000 genetically different strains of rice in India.
- b. **Species Diversity:** Variety of species within a region.  
e.g.:- Western Ghats have greater amphibian species diversity than Eastern Ghats.
- c. **Ecological Diversity:** Number of ecosystems on a larger area.  
e.g. :- India has far more ecosystems than Scandinavia.

### 2. Patterns Of Biodiversity:

- a. **Latitudinal Gradients-** biodiversity highest in tropics and decrease towards poles.

#### **Reasons for species richness in tropics-**

- i. Tropic had more evolutionary time for speciation.
  - ii. Provide a relatively constant environment.
  - iii. Receive more solar energy which contributes greater productivity.
- b. **Species-Area relationship**- represents the richness of a species based on the explored area. Richness increases with increase in explored area but only to a limit making a rectangular hyperbolic function ( $\text{Log } S = \text{Log } C + Z \text{Log } A$ ).  
For any particular species, the regression coefficient (Z) lies within 0.1 to 0.2  
However, if the area explored extends to continents, then Z ranges 0.6 to 1.2

### 3. Importance of species diversity to the ecosystem:

- a. **David Tilman's** long term ecosystem experiments showed that plots with more species showed less year to year variation (more stable) in total biomass and therefore have higher productivity.
- b. Stable community must be either resistant or resilient to occasional disturbances (natural or manmade).
- c. Stable community also resistant to invasions by alien species

**Paul Ehrlich (Rivet popper hypothesis)** has explained the importance of species diversity. Considering an airplane as an ecosystem, with all its parts being joined by rivets (individual species). If passengers start removing rivets one by one, initially there will not be much effect on plane. But with more removal the plane will become structurally unstable and crash. Similarly, removing species from an ecosystem may affect it adversely.

Also the severity of effect depends upon the type of species being removed. Species at a critical juncture in the ecosystem may be sufficient in itself to cause huge damage.

### 4. Effects of loss of biodiversity-

- a. Decline in plant production.
- b. Lowered resistance to environmental perturbations such as drought.
- c. Increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycle.

### 5. Causes of biodiversity losses-

Four major causes collectively known as 'The Evil Quartet'

- a. **Habitual loss and fragmentation**- Total loss of habitat or when a large habitat is broken into small fragments or even degradation of habitats due to any human activities threatening the survival of many species.
- b. **Over-Exploitation**- Steller's sea cow and passenger pigeon were extinct due to over exploitation.
- c. **Alien Species invasions**-
  - i. Introduction of Nile perch into Lake Victoria in east Africa led to extinction of more than 200 species of cichlid fishes.
  - ii. Carrot grass(parthenium),lantana, water hyacinth(Eichornia)
  - iii. Recent illegal introduction of African cat fish Clarias gariepinus for aquaculture is posing threat to indigenous catfishes in our rivers.
- d. **Co-extinction**-
  - i. When a host fish species extinct, parasites automatically extinct.
  - ii. Plant pollinator mutualism-extinction of one invariably leads to the extinction of other.

### 6. Biodiversity Conservation-

Biodiversity is vital for very survival of mankind. Reasons can be grouped in three categories:

- a. **Narrowly utilitarian**- Direct economic benefits from nature (food, fiber, medicines, tannins, oils, alkaloids etc.)
- b. **Broadly utilitarian**- Biodiversity plays a major role in many ecosystems services that nature provides like:
  - i. Amazon forests produce 20% of the total oxygen through photosynthesis.
  - ii. Pollination without which no fruits & seeds.
  - iii. Provide aesthetic pleasure.

Can one estimate the value of these services. More and more bio-prospecting will highlight the value of other natural resources.

- c. **Ethical-** Every species has an intrinsic value, so it is a moral duty of humans to care for the well-being of all organisms & pass on our biological legacy to future generations.

**Different strategies to conserve biodiversity-**

1. **In-situ conservation:** To protect and conserve the whole ecosystem, its biodiversity at all levels. E.g. :- Save entire forest to save tiger (Project Tiger).

**In Situ : Protected area network**

- a. Sacred grooves :- Found in Khasi & Jaintia hills Aravali hills of Rajasthan.
  - b. National Parks and wild life sanctuaries.
  - c. Biosphere Reserve
- e.g :- India: 14( Biosphere Reserve ), 90 (National Parks), 448( wild life sanctuaries)

2. **Ex-situ Conservation:** Threatened animals and plants are shifted from their natural habitat to artificial settings where they can be protected and given special care.

**Ex- Situ**

- a. (i) Botanical Garden (ii) Zoological Gardens (iii) Aquarium.
- b. Seed bank, cryo preservation
- c. Plant tissue culture
- d. In-vitro fertilization.

**7. Biodiversity Hot Spots:-**

Criteria for determining the Hot Spots-

- a. Regions with high levels of species richness.
- b. High degree of endemism (species of that region and not found anywhere else)
- c. Degree of threat, which is measured in terms of habitat loss.

**Three hot spots** cover India's high biodiversity regions are-

- i. Western / Eastern Ghats and Sri Lanka
- ii. Indo-Burma.
- iii. Himalayas.

**8. International efforts for conserving biodiversity.**

**a. Earth summit (1992) at Rio De Janeiro:-**

Objectives-

- i. Conservation of biodiversity
- ii. Sustainable utilization.
- iii. Fair and equitable sharing of benefits arising out of the utilization of genetic resources.

**b. World summit (2002), Johannesburg, South Africa:-**

Objective: Sustainable development.

A significant reduction in the current rate of biodiversity loss at global, regional and local levels by the year 2010.

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**CHAPTER - 15**  
**BIODIVERSITY & CONSERVATION**  
**PRACTICE MCQ's**

1. The presence of approximately 1000 varieties of mangoes in India signifies its:
  - a. Ecological diversity
  - b. Genetic diversity
  - c. Species diversity
  - d. Species integrity
2. As we move from equator to poles, the diversity of life forms decrease. This may not be attributed to:
  - a. Length of day
  - b. Length of night
  - c. Extensive rainfall
  - d. Average temperature 20<sup>0</sup>C
3. Many species have undergone extinction with the exception:
  - a. Sahiwal cow India
  - b. Steller Cow Russia
  - c. Caspian tiger
  - d. Dodo of Mauritius
4. IUCN stands for:
  - a. Indian Union of Cultural Network
  - b. International Universal Convention of Nature
  - c. Indian Universal Convention of Nature
  - d. International Union Conservation of Nature
5. The terms phycobiont and the mycobiont are used in reference to:
  - a. Fungal and algal partner in the lichens
  - b. Cynobacterial and fungal partners in the lichens
  - c. Algal and fungal partners in the lichens
  - d. Cynobacterial and algal partners in the lichens
6. The loss of biodiversity is credited to:
  - i. Habitat fragmentation
  - ii. Native species invasion
  - iii. Co-extinction
  - iv. Under exploitation
  - a. (i) and (ii)
  - b. (ii) and (iii)
  - c. (i) and (iii)
  - d. (ii) and (iv)
7. Loss of biodiversity may not lead to:
  - a. Decline in plant production
  - b. Lowered resistance to environmental stress
  - c. Better survival rate of species in the ultimate zone of food chain
  - d. Increased variability in certain ecosystems regarding disease cycle
8. Broadly utilitarian advantage of biodiversity is obtaining \_\_\_\_\_ form nature:
  - a. Fire wood
  - b. oxygen
  - c. Food
  - d. Medicines

**Assertion and Reason:**

- a. If both 'A' and 'R' are correct and 'R' is the correct explanation of the 'A'.
  - b. If both 'A' and 'R' are correct and 'R' is not the correct explanation of the 'A'.
  - c. If 'A' is correct but 'R' is false.
  - d. If 'A' is false but 'R' is correct.
9. **Assertion:** The environment summits constitute an approach to nature conservation.  
**Reason:** Such summits are a platform to help the nations to think for the collective survival.
10. **Assertion:** In situ conservation is considered the best way of conservation.  
**Reason:** In situ conservation not only conserves the threatened species in question but results in the conservation of the habitat as a whole.

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