BT501 – HEALTH BIOTECHNOLOGY

MID TERM MOST IMPORTANT QUESTIONS

PREPARED BY: *SIR MUGHAL* (ADMIN, BS BIOLOGICAL SCIENCES)

GROUP LINK: https://chat.whatsapp.com/BjC6W0jZx8o9yaC2ISh1Gu

1. Write a short note on Hemophilia.

Hemophilia is a rare inherited bleeding disorder in which the blood doesn't clot properly due to the absence or low levels of certain clotting factors. It is usually caused by a genetic mutation and is most commonly passed from mother to son through the X chromosome, making it an X-linked recessive disorder. There are two main types:

- ***Hemophilia A*** – caused by a deficiency of clotting factor VIII.
- ***Hemophilia B*** – caused by a deficiency of clotting factor IX.

Symptoms include:

- Prolonged bleeding after injury or surgery
- Spontaneous bleeding into joints and muscles
- Easy bruising

Treatment typically involves regular injections of the missing clotting factor (factor replacement therapy) to prevent or control bleeding. With proper management, people with hemophilia can lead relatively normal lives.

2. What is Hemagglutination test?

The hemagglutination test is a laboratory technique used to detect the presence of antibodies or antigens in a sample by observing the clumping (agglutination) of red blood cells (RBCs)**.**

Principle:

Hemagglutination occurs when antibodies bind to antigens on the surface of RBCs, causing them to clump together. This visible clumping is used as an indicator of a positive reaction.

Types:

- ***Direct Hemagglutination Test*** – detects antibodies that directly agglutinate red blood cells. For example: Blood typing (ABO and Rh).
- ***Indirect (Passive) Hemagglutination Test*** – RBCs are coated with antigens artificially, and then patient serum is tested for antibodies. It is used for diagnosing infections like typhoid**,** syphilis**,** or viral diseases.

Applications:

- Blood group determination
- Diagnosis of infections
- Detection of specific antibodies in serological testing

3. What are Liposomes?

Liposomes are small, spherical vesicles composed of one or more phospholipid bilayers, similar to the structure of a cell membrane. They can encapsulate both hydrophilic (water-soluble) and hydrophobic (fat-soluble) substances.

Structure:

- ***Hydrophilic core*** – holds water-soluble drugs.
- ***Phospholipid bilayer*** – can trap fat-soluble drugs.

Key Features:

- Biocompatible and biodegradable
- Can carry drugs, enzymes, or genetic material
- Protect contents from degradation in the body

Applications:

- ***Drug delivery systems*** – especially for cancer, fungal infections, and vaccines.
- ***Cosmetics*** – for controlled delivery of active ingredients.
- ***Gene therapy*** – as vectors for delivering DNA or RNA.

4. What is Tay-Sachs disease?

Tay-Sachs disease is a rare, inherited genetic disorder that causes the progressive destruction of nerve cells (neurons) in the brain and spinal cord. It is most commonly seen in infants and is caused by a mutation in the HEXA gene on chromosome 15.

Cause:

- Deficiency of the enzyme hexosaminidase A (Hex-A)**.**
- This enzyme is needed to break down a fatty substance called GM2 ganglioside**.**
- Without it, GM2 builds up in nerve cells, leading to neuronal damage and death.

Inheritance:

- ***Autosomal recessive*** – both parents must carry the faulty gene.

Symptoms (usually appear by 6 months of age):

- Loss of motor skills
- Muscle weakness
- Exaggerated startle response
- Seizures
- Vision and hearing loss
- Paralysis
- "Cherry-red" spot in the eye (retina)

Prognosis:

- Severe infantile form leads to death typically by age 4–5.
- No cure; treatment is supportive.

5. What are advantages of PCR based test?

Advantages of PCR-Based Tests:

1. ***High Sensitivity:*** PCR (Polymerase Chain Reaction) can detect even very small amounts of DNA or RNA, making it ideal for early diagnosis.
2. ***High Specificity:*** Specific primers are used to target unique genetic sequences, reducing the chance of false positives.
3. ***Rapid Results:*** PCR can produce results within a few hours, making it much faster than traditional culture methods.
4. ***Detection of Non-Culturable Organisms:*** It can identify pathogens that are difficult or impossible to grow in the lab.
5. ***Versatility:*** PCR can be used to detect genetic mutations, infectious agents (like viruses and bacteria), and for forensic and research purposes.
6. ***Quantification (with real-time PCR):*** Allows measurement of the amount of target DNA/RNA in a sample.
7. ***Minimal Sample Requirement:*** Requires only a small amount of biological material (e.g., blood, saliva, tissue).
8. ***Automation Compatibility:*** PCR can be automated for high-throughput testing in clinical labs.

6. What is RNAi?

RNAi (RNA interference):

RNA interference (RNAi) is a natural biological process in which small RNA molecules inhibit gene expression by silencing specific messenger RNA (mRNA)**,** preventing the production of certain proteins.

Key Components:

1. siRNA (small interfering RNA)
2. miRNA (microRNA)

   Both bind to target mRNA molecules and lead to their degradation or block their translation.

Mechanism:

- Double-stranded RNA is processed by an enzyme called Dicer into siRNA or miRNA.
- These are then incorporated into a protein complex called RISC (RNA-induced silencing complex)**.**
- RISC uses the RNA strand as a guide to find and bind to complementary mRNA.
- The target mRNA is then degraded or silenced, stopping protein production.

Applications:

- Gene function studies
- Therapeutic gene silencing (e.g., in cancer or viral infections)
- Biotechnology and agriculture (e.g., pest-resistant crops)

7. Write and explain applications of DNA microarray technology.

Applications of DNA Microarray Technology

DNA microarray technology is a powerful tool used to analyze the expression of thousands of genes simultaneously. It involves attaching DNA probes to a solid surface (like a chip) and hybridizing them with fluorescently labeled target DNA or RNA to detect gene activity.

Key Applications:

- ***Gene Expression Profiling:*** Used to compare gene expression levels in different cells or conditions (e.g., normal vs. cancerous tissues). It helps identify genes involved in diseases or biological processes.
- ***Disease Diagnosis and Classification:*** Microarrays can detect specific gene expression patterns associated with certain diseases (e.g., types of cancer), aiding in accurate diagnosis and personalized treatment plans.
- ***Drug Discovery and Development:*** Helps identify how genes respond to new drug candidates. It also assists in predicting drug efficacy and toxicity.
- ***Genetic Variation and Mutation Analysis:*** Detects single nucleotide polymorphisms (SNPs) and mutations associated with genetic disorders.
- ***Pathogen Detection and Typing:*** Identifies infectious agents by detecting their genetic material. Also useful in monitoring outbreaks and determining pathogen strains.
- ***Comparative Genomic Hybridization (CGH):*** Used to detect chromosomal abnormalities and gene copy number variations in diseases like cancer.

8. Which conditions leads to the dysfunction of mitochondria in Parkinson's disease?

Conditions Leading to Mitochondrial Dysfunction in Parkinson's Disease:

Mitochondrial dysfunction is a key factor in the development and progression of Parkinson's disease (PD). Several conditions contribute to this dysfunction:

1. Genetic Mutations:

- Mutations in genes like PINK1**,** Parkin, DJ-1**,** and LRRK2 impair mitochondrial function.
- PINK1 and Parkin are involved in mitochondrial quality control and mitophagy (removal of damaged mitochondria).

2. Oxidative Stress:

- Mitochondria are a major source of reactive oxygen species (ROS).
- In PD, excess ROS damages mitochondrial DNA, proteins, and membranes, impairing energy production.

3. Environmental Toxins:

- Exposure to toxins like MPTP, paraquat, and rotenone inhibits Complex I of the mitochondrial electron transport chain.
- This leads to ATP depletion and increased ROS, contributing to neuron death.

4. Impaired Mitophagy:

- Failure to remove damaged mitochondria results in accumulation of dysfunctional mitochondria.
- This leads to cellular stress and apoptosis (cell death).

5. Calcium Imbalance:

- Abnormal calcium handling in neurons can stress mitochondria, triggering dysfunction and cell death.

6. Alpha-Synuclein Aggregation:

- Aggregated alpha-synuclein, a hallmark of PD, can interact with mitochondria and disrupt their function, including impairing mitochondrial dynamics and transport.

9. Write the genetics of Huntington's disease.

Genetics of Huntington's Disease

- Huntington's disease (HD) is caused by a mutation in the HTT gene located on chromosome 4.
- The mutation involves an abnormal expansion of CAG trinucleotide repeats in the gene.
- Normally, the HTT gene contains 10 to 35 CAG repeats, but in HD patients, the number of repeats is 36 or more**.**
- The larger the number of repeats, the earlier the onset and more severe the disease.
- HD is inherited in an autosomal dominant pattern, meaning only one copy of the mutated gene is enough to cause the disorder.
- Each child of an affected parent has a 50% chance of inheriting the mutation.
- The mutation leads to production of an abnormal huntingtin protein that causes neuronal damage, particularly in the brain's basal ganglia.

10. Explain types of monogenetic disorders.

Monogenic disorders are caused by mutations in a single gene. They can be classified based on their mode of inheritance into three main types:

1. Autosomal Dominant Disorders

Only one mutated copy of the gene (from either parent) is sufficient to cause the disease. Affected individuals usually have an affected parent. Examples are: Huntington's disease, Marfan syndrome and Achondroplasia.

2. Autosomal Recessive Disorders

Two mutated copies of the gene (one from each parent) are required for the disease to manifest. Parents are usually carriers without symptoms. Examples are: Cystic fibrosis, Sickle cell anemia and Tay-Sachs disease.

3. X-Linked Disorders

Caused by mutations in genes on the X chromosome. Mostly affect males (who have only one X chromosome), while females are usually carriers. Examples are: Hemophilia A and B, Duchenne muscular dystrophy and Fragile X syndrome.

11. Explain composition of Liposomes in drug delivery.

Liposomes are vesicles used to deliver drugs effectively. Their composition mainly includes:

1. Phospholipids

- The primary component forming the bilayer membrane of liposomes.
- Common phospholipids used are phosphatidylcholine (PC), phosphatidylethanolamine (PE), and phosphatidylserine (PS).
- They provide biocompatibility and help encapsulate both hydrophilic and hydrophobic drugs.

2. Cholesterol

- Incorporated into the bilayer to stabilize the membrane.
- It controls the fluidity and permeability of liposomes, increasing their durability in the bloodstream.

3. Hydrophilic Core

- The inner aqueous space that encapsulates water-soluble drugs or molecules.

4. Surface Modifiers (optional)

- Sometimes, liposomes are coated with molecules like polyethylene glycol (PEG) (called PEGylation) to improve circulation time by avoiding immune detection.
- Targeting ligands (e.g., antibodies) can also be attached for targeted drug delivery.

12. Write applications of rDNA in agriculture, pharmacology and medicine.

Applications of rDNA Technology

In Agriculture:

- Development of genetically modified (GM) crops with improved traits such as pest resistance (e.g., Bt cotton), herbicide tolerance, drought resistance, and enhanced nutritional content (e.g., Golden Rice).
- Production of disease-resistant plants, reducing the need for chemical pesticides.
- Improvement in crop yield and shelf-life.

In Pharmacology:

- Production of recombinant proteins such as insulin, growth hormones, and clotting factors.
- Development of vaccines, including recombinant vaccines like the Hepatitis B vaccine.
- Creation of gene therapy vectors for targeted treatments.

In Medicine:

- Diagnosis of genetic disorders using recombinant DNA probes.
- Production of monoclonal antibodies for targeted therapies.
- Development of personalized medicine through genetic engineering.
- Gene therapy to correct defective genes responsible for diseases.

13. Write technique involved in rDNA.

Techniques Involved in rDNA Technology

1. ***Isolation of DNA:*** Extraction of DNA from the donor organism containing the gene of interest.
2. ***Cutting DNA with Restriction Enzymes:*** Specific enzymes called restriction endonucleases cut DNA at particular sequences, producing fragments with sticky or blunt ends.
3. ***Isolation of Vector DNA:*** A suitable vector (like a plasmid or viral DNA) is isolated to carry the gene into the host cell.
4. ***Ligation:*** The gene of interest is inserted into the vector DNA using the enzyme DNA ligase, which joins the DNA fragments together, forming recombinant DNA.
5. ***Transformation:*** The recombinant DNA is introduced into a host organism (usually bacteria) through methods like heat shock or electroporation.
6. ***Selection and Screening:*** Host cells that have taken up the recombinant DNA are selected using antibiotic resistance or marker genes, and screened for the desired gene.
7. ***Expression and Cloning:*** The host cells replicate, producing multiple copies of the recombinant gene and, if applicable, expressing the desired protein.

14. Write three trisomy with disorder, name and number of chromosomes.

Here are three examples of trisomy disorders:

1. **Down Syndrome**
   - ***Disorder:*** Down syndrome
   - ***Chromosome affected:*** Chromosome 21
   - ***Number of chromosomes:*** 47 (trisomy 21)
2. **Edward Syndrome**
   - ***Disorder:*** Edwards syndrome
   - ***Chromosome affected:*** Chromosome 18
   - ***Number of chromosomes:*** 47 (trisomy 18)
3. **Patau Syndrome**
   - ***Disorder:*** Patau syndrome
   - ***Chromosome affected:*** Chromosome 13
   - ***Number of chromosomes:*** 47 (trisomy 13)

15. Define cardiovascular disease, symptoms, affects, possible causes and treatment.

Cardiovascular Disease (CVD) is a group of disorders affecting the heart and blood vessels, such as coronary artery disease, heart attack, stroke, and hypertension. It is one of the leading causes of death worldwide.

Symptoms of CVD vary depending on the specific condition but often include chest pain or discomfort (angina), shortness of breath, fatigue, irregular heartbeat (palpitations), and dizziness, fainting, and swelling in the legs, ankles, or feet. Some individuals may remain asymptomatic until a serious event like a heart attack or stroke occurs.

Effects of CVD can be severe and life-threatening. It may lead to reduced blood flow to the heart or brain, damage to the heart muscle, heart failure, stroke, or even sudden cardiac death. Long-term complications can also include organ damage due to poor circulation and decreased quality of life.

Causes of CVD include a combination of genetic and lifestyle factors. Major risk factors are high blood pressure, high cholesterol levels, smoking, diabetes, obesity, physical inactivity, unhealthy diet, chronic stress, and excessive alcohol use. A family history of heart disease can also increase the risk.

Treatment for CVD involves both lifestyle modifications and medical interventions. Patients are advised to adopt a heart-healthy lifestyle, including regular exercise, a balanced diet, quitting smoking, and managing stress. Medications such as antihypertensives, statins, and anticoagulants may be prescribed. In more severe cases, procedures like angioplasty, stent placement, or bypass surgery may be necessary. Ongoing monitoring and management of underlying conditions are crucial for effective treatment and prevention.

16. What are types of vaccines?

There are several types of vaccines, each designed to trigger an immune response in different ways:

1. ***Live attenuated vaccines -*** use a weakened form of the germ that causes a disease. Because they are the closest thing to a natural infection, they create a strong and long-lasting immune response. Examples include the measles, mumps, and rubella (MMR) vaccine and the yellow fever vaccine.

2. ***Inactivated vaccines -*** are made from germs that have been killed. They don't provide immunity as strong as live vaccines, so multiple doses or boosters may be needed. Examples include the polio and hepatitis A vaccines.

3. ***Subunit, recombinant, polysaccharide, and conjugate vaccines -*** use specific pieces of the germ—like its protein, sugar, or capsid. Because these vaccines use only essential antigens and not the whole germ, they produce a targeted immune response with fewer side effects. Examples include the HPV and whooping cough (pertussis) vaccines.

4. ***Toxoid vaccines -*** prevent diseases caused by bacteria that produce toxins in the body. These vaccines neutralize the toxin rather than the bacteria itself. The diphtheria and tetanus vaccines are examples.

5. ***mRNA vaccines -*** use genetically engineered mRNA to instruct cells to produce a protein that triggers an immune response. These are a newer type of vaccine, used in some COVID-19 vaccines.

6. ***Viral vector vaccines -*** use a modified version of a different virus (the vector) to deliver genetic material that helps the body build protection. Some COVID-19 vaccines, like the Johnson & Johnson vaccine, use this method.

17. Write steps of monoclonal antibodies production.

The production of monoclonal antibodies involves several key steps:

1. First, an antigen is injected into a mouse to stimulate its immune system to produce antibodies against that specific antigen. After a few days, B-lymphocytes (a type of white blood cell that produces antibodies) are isolated from the spleen of the mouse.
2. Next, these B-lymphocytes are fused with myeloma cells (a type of immortal cancer cell) to create hybrid cells known as hybridomas. This fusion combines the antibody-producing ability of B-cells with the immortality of myeloma cells.
3. The hybridomas are then cultured and screened to identify those producing the desired antibody. Only the hybridomas that produce the specific monoclonal antibody are selected and cloned.
4. Finally, the selected hybridoma cells are cultured on a large scale to produce large quantities of monoclonal antibodies, which are then collected, purified, and used for diagnostic or therapeutic purposes.

18. Which protein biomarker is used in Ovarian cancer? Write its steps.

The protein biomarker commonly used in ovarian cancer is CA-125 (Cancer Antigen 125). Here are the steps involved in using CA-125 as a biomarker for ovarian cancer:

1. First, a blood sample is collected from the patient. The sample is then processed in a laboratory to measure the level of CA-125 in the blood using techniques such as ELISA (enzyme-linked immunosorbent assay).

2. The measured CA-125 level is compared to the normal range. A value above the typical threshold (usually >35 U/mL) may indicate the presence of ovarian cancer, although elevated levels can also occur in other conditions like endometriosis, menstruation, or pelvic inflammatory disease.

3. If CA-125 levels are high, the doctor may recommend further diagnostic tests such as a transvaginal ultrasound or CT scan to check for tumors or abnormalities in the ovaries.

4. In diagnosed cases of ovarian cancer, CA-125 levels are also monitored over time to assess treatment response and detect recurrence after therapy. A declining CA-125 level during treatment often indicates that the therapy is effective, while rising levels after treatment may suggest a recurrence.

19. Define Biotechnology. How classical biotechnology is different from modern biotechnology?

Biotechnology is the branch of science that uses living organisms, cells, or biological systems to develop products and technologies for the benefit of humans, animals, and the environment. It combines biology with other fields like chemistry, genetics, and engineering to solve real-world problems in medicine, agriculture, industry, and environmental management.

Classical biotechnology refers to traditional techniques that have been used for centuries, such as fermentation, selective breeding, and the use of microorganisms to make products like bread, alcohol, cheese, and yogurt. It relies on naturally occurring processes without direct manipulation of genetic material.

Modern biotechnology, on the other hand, involves advanced techniques such as genetic engineering, recombinant DNA technology, tissue culture, and molecular diagnostics. It allows scientists to directly alter the genetic material of organisms to create genetically modified organisms (GMOs), produce insulin, vaccines, and conduct gene therapy. Modern biotechnology is more precise, faster, and capable of achieving results that classical methods cannot.

20. Define Allele specific hybridization of cystic fibrosis.

- Allele-specific hybridization is a molecular technique used to detect specific genetic mutations, such as those responsible for cystic fibrosis.
- In the case of cystic fibrosis, this method is used to identify mutations in the CFTR gene, particularly the most common one, ΔF508.
- The process involves the following steps:
- First, a DNA sample is extracted from the patient's cells. Short, synthetic DNA probes are designed that are complementary to either the normal (wild-type) allele or the mutant allele.
- The patient's DNA is then denatured (separated into single strands) and allowed to hybridize (bind) with the allele-specific probes under controlled conditions.
- If the patient carries the mutant allele, it will specifically bind to the mutant probe; if the patient has the normal allele, it will bind to the normal probe. The hybridization is usually detected using labeled probes (e.g., with fluorescent or radioactive markers).
- By analyzing which probes the DNA binds to, one can determine whether the person is homozygous normal, heterozygous carrier, or homozygous mutant for cystic fibrosis.

21. What is hybridization probe?

A hybridization probe is a short, single-stranded sequence of DNA or RNA that is designed to bind (or hybridize) to a specific complementary sequence of nucleic acids in a sample. Probes are usually labeled with a detectable marker, such as a fluorescent dye, radioactive isotope, or enzyme, so that the binding can be visualized or measured. They are commonly used in techniques like Southern blotting, Northern blotting, in situ hybridization, and allele-specific hybridization to detect the presence of specific DNA or RNA sequences, identify mutations, or diagnose genetic diseases.

22. What is fragile X syndrome?

Fragile X syndrome is a genetic disorder caused by a mutation in the FMR1 gene (Fragile X Mental Retardation 1) located on the X chromosome. The condition occurs when a section of the gene (a CGG trinucleotide repeat) is abnormally expanded. In individuals with fragile X syndrome, the number of CGG repeats exceeds 200, which leads to the silencing of the FMR1 gene and a deficiency of the FMRP protein. This protein is essential for normal brain development and function.

Fragile X syndrome is the most common inherited cause of intellectual disability and a known genetic cause of autism spectrum disorder. It affects both males and females, but males are usually more severely affected due to having only one X chromosome.

Common symptoms include developmental delays, learning disabilities, intellectual impairment, speech and language difficulties, behavioral issues (such as hyperactivity or anxiety), and physical features like a long face, large ears, and flexible joints. Diagnosis is typically confirmed through genetic testing to analyze the number of CGG repeats in the FMR1 gene.

23. Define recombinant DNA and its steps of using gene cloning.

Recombinant DNA (rDNA) is a form of artificial DNA that is created by combining DNA from two or more different sources, often from different species. This technique allows scientists to insert a gene of interest (e.g., a human gene) into a vector (such as a plasmid) to be replicated or expressed in a host organism, usually bacteria.

Steps of Gene Cloning Using Recombinant DNA Technology:

Gene cloning using recombinant DNA involves the following key steps**:**

1. Isolation of the Gene of Interest: The target gene (e.g., a human insulin gene) is identified and extracted from the source DNA using restriction enzymes (also called restriction endonucleases).

2. Selection of a Suitable Vector: A vector (often a plasmid or a virus) is selected to carry the gene. Vectors must be capable of replicating within a host cell. Plasmids are circular DNA molecules commonly used as vectors.

3. Insertion of the Gene into the Vector (Recombinant DNA Formation): The gene of interest is inserted into the vector using the same restriction enzyme that cut the source DNA. DNA ligase enzyme is used to join the gene and vector together, forming recombinant DNA.

4. Introduction into a Host Cell (Transformation): The recombinant DNA is introduced into a host organism, typically a bacterium (like *E. coli*), through a process called transformation. Methods include heat shock or electroporation to make bacterial membranes permeable.

5. Selection and Screening of Transformed Cells: Only bacteria that successfully take up the recombinant DNA are selected using antibiotic resistance genes or marker genes present on the plasmid. Colonies are screened to confirm the presence of the desired gene.

6. Cloning and Expression: The transformed bacteria replicate, producing multiple copies (clones) of the gene. If the gene is under a suitable promoter, the host may also express the protein encoded by the gene (e.g., insulin).

24. What is Nano Biotechnology and its application is in medicines?

Nano Biotechnology (also called Nanobiotechnology) is a branch of science that combines nanotechnology and biotechnology to develop tools and techniques at the nanoscale (1 to 100 nanometers) to study, manipulate, or deliver biological systems. In simpler terms, it involves using tiny materials or devices (called nanoparticles or nanodevices) to understand and interact with biological systems such as cells, proteins, or DNA, especially for medical and health-related applications.

Applications of Nano Biotechnology in Medicine:

Nano biotechnology has revolutionized medicine in several ways. Here are some key applications:

1. Drug Delivery: Targeted drug delivery using nanoparticles helps deliver drugs directly to diseased cells, such as cancer cells, minimizing side effects. Example: Liposomal nanoparticles carrying chemotherapy drugs target only cancer cells.

2. Diagnostics (Nano-diagnostics): Nano-based sensors and devices can detect diseases at a very early stage**.** Example: Gold nanoparticles are used in rapid tests for detecting viruses or cancer biomarkers.

3. Cancer Treatment (Nano-oncology): Nanoparticles can deliver anti-cancer drugs specifically to tumors, reducing harm to healthy tissues. Magnetic nanoparticles can be guided to tumor sites using external magnetic fields.

4. Regenerative Medicine and Tissue Engineering: Nanomaterials like nanofibers can be used to create scaffolds that help regenerate damaged tissues or organs. They mimic natural biological structures.

5. Imaging and Diagnosis: Nanoparticles enhance the clarity of imaging techniques like MRI, PET, or CT scans. Quantum dots can be used to label and track cells or proteins in the body.

6. Antibacterial and Antiviral Treatments: Silver nanoparticles are used in coatings or dressings to kill bacteria and prevent infections. Nanoparticles can also be used to deliver vaccines or enhance immune responses.

7. Gene Therapy: Nanoparticles can be used to carry genes or CRISPR-Cas9 components into cells to correct genetic defects.

Disclaimer:

For best results, it is advised NOT to rely on this file only. Go through video lectures, handouts and other sources as well.

Regards,

Sir Mughal,

BS Zoology, Virtual University of Pakistan

B.Sc (Honors), University of Karachi.