Review of MICROBIOLOGY & IMMUNOLOGY

7th Edition

Thoroughly Revised and Updated
All Image-based Microbiology MCQs of 2017—came from this book

Review of MICROBIOLOGY & IMMUNOLOGY


Latest updates included such as BMW Rule 2016, Zika, H1N1, EBOLA virus, Polio eradication, Vaccine-derived PolioViruses (VDPVs), MERS-CoV, etc.

Recent questions included from PG—2017 (Nov and May), JIPMER—2017 (Nov and May), AIIMS—2017 (Nov and May) and NEET 2018 Pattern Questions, latest MCQs from other national and state entrances.


Only MCQs book on Microbiology written by the subject specialist and textbook authors.

Thoroughly revised, updated and fully colored edition.

Interactive 2 hours DVD containing Apurba Sastry’s Microbiology Discussion.

Each chapter contains:
- Chapterwise concise complete text in a new layout for enabling the students to study antegrade manner and important points given in separate boxes
- Chapterwise MCQs with detailed explanations given from previous years exams of National and State exams including DNBA and NEET Pattern Questions.
- Hundred percent authentic and correct answers with the updated references.
- More emphasis is given to the sections like Immunology, Parasitology and Mycology.
- The book contains lot of tables, flowcharts, mnemonics which help the students for better recall.
- This book is useful for interns, students preparing for entrance exams and for second professional students.
- For any queries, suggestions and feedback kindly join us at Facebook page Jaypeeexamsone.

Author’s online support

ASM Discussion on FB and ASM Test for 2017

JOIN APURBA SASTRY’S MICROBIOLOGY DISCUSSION ON FB at https://www.facebook.com/groups/877883649824990/

WRITE ASM TEST at http://accessjaypee.com/asmtest

Available at all medical bookstores or buy online at www.jaypeebrothers.com

JAYP EE BROTHERS
Medical Publishers (P) Ltd.
www.jaypeebrothers.com

Join us on facebook.com/JaypeeMedicalPublishers

A purba Sankar Sastry • Sandhya Bhat K

7th Edition
Contents

Section 1: General Microbiology

Chapter 1.1 History, Taxonomy, Morphology and Physiology of Bacteria and Microbial Pathogenicity 3
Chapter 1.2 Sterilization and Disinfection 13
Chapter 1.3 Culture Media and Methods, Identification of Bacteria by Conventional, Automated and Molecular Methods 25
Chapter 1.4 Bacterial Genetics and Antimicrobial Resistance 34

Section 2: Immunology

Chapter 2.1 Immunity 46
Chapter 2.2 Antigen, Antibody, Antigen-Antibody Reaction, Complement 52
Chapter 2.3 Structure of Immune System and Immune Response 74
Chapter 2.4 Hypersensitivity 89
Chapter 2.5 Autoimmunity, Immunodeficiency, Transplantation, and Immunoprophylaxis 95

Section 3: Systemic Bacteriology

Chapter 3.1 Staphylococcus 113
Chapter 3.2 Streptococcus, Enterococcus and Pneumococcus 123
Chapter 3.3 Neisseria and Moraxella 136
Chapter 3.4 Corynebacterium and Bacillus 144
Chapter 3.5 Anaerobes: Clostridium and Non-Sporing Anaerobes 157
Chapter 3.6 Mycobacteria 172
Chapter 3.7 Enterobacteriaceae (E. Coli, Klebsiella, Proteus, Shigella, Salmonella, Yersinia) 195
Chapter 3.8 Vibrio 216
Chapter 3.9 Pseudomonas and Other Nonfermenters, and Haeomophilus, Bordetella, Brucella (HBB) 238
Chapter 3.10 Spirochetes 244
Chapter 3.11 Rickettsia, Chlamydia and Mycoplasma 260
Chapter 3.12 Miscellaneous Bacteria 276

Section 4: Virology

Chapter 4.1 General Properties of Viruses 297
Chapter 4.2 Herpesviruses and Other DNA Viruses 307
Chapter 4.3 Myxoviruses and Rubella 328
Chapter 4.4 Arboviruses, Picornaviruses and Rabies Virus 345
Chapter 4.5 Hepatitis Viruses 374
Chapter 4.6 HIV and Other Retroviruses 361
Chapter 4.7 Miscellaneous Viruses 407

Section 5: Mycology

Chapter 5.1 General Parasitology 421

Section 6: Parasitology

Chapter 6.1 General Parasitology 451
Chapter 6.2 Intestinal Amebae, Free-living Amebae and Balantidium Coli 455
Chapter 6.3 Flagellates 463
Chapter 6.4 Plasmodium Species and Babesia 472
Chapter 6.5 Coccidian Parasites 484
Chapter 6.6 Cestodes and Trematodes 490
Chapter 6.7 Nematodes 504

Section 7: Applied Microbiology

Chapter 7.1 Clinical Microbiology (Infective Syndromes) 523
Chapter 7.2 Hospital Acquired Infection, Biomedical Waste, Bacteriology of Water, Air and Milk 541
1. Eminent microbiologists in past:
   1a. Antonie van Leeuwenhoek, 1b. Louis Pasteur, 1c. Robert Koch, 1d. Paul Ehrlich

2. Cell wall: Differences between Peptidoglycan layer of:
   2a. gram-positive cell wall and
   2b. gram-negative cell wall. (Refer chapter review 1.1 for detail).

3. Culture media:
   3a. Peptone water, 3b. Nutrient agar, 3c. Blood agar, 3d. Chocolate agar

32. Nonfermenters
   32a. Blue green pigmentation (diffuse) on nutrient agar: Pseudomonas aeruginosa
   32b. Bipolar staining of Burkholderia
   32c. Ashdown medium of Burkholderia showing dry wrinkled colonies

33. Haemophilus influenzae:
   33a. Blood agar showing Satellitism: Colonies of H. influenzae are larger adjacent to the streak line of S. aureus
   33b. Pleomorphic gram-negative bacilli
   33c. Colonies of H. influenza on chocolate agar

34. Bordetella pertussis:
   34a. Child suffering from whooping cough
   34b. Mercury drop colonies on Regan low media
   34c. Gram stain shows gram-negative cocccobacilli (thumb print appearance)
BACTERIAL GENETICS

Bacterial genetics deals with the study of heredity and variation seen in bacteria. All hereditary characteristics of the bacteria are encoded in their DNA which is present in chromosome as well as extrachromosomal genetic material as plasmid.

Plasmid

Plasmids are the extrachromosomal ds circular DNA molecules that exist in free state in the cytoplasm of bacteria and also found in some yeasts.

- Not essential for life. Bacteria may gain or lose plasmid during their lifetime.
- Numbers: They may be present singly or in multiple numbers up to > 40 plasmids per cell.
- Capable of replicating independently
- Episome: Plasmid may integrate with chromosomal DNA of bacteria and such plasmids are called episomes.
- Curing: The process of eliminating the plasmid(s) from bacteria is known as curing.

Classification of Plasmids

1. Based on ability to perform conjugation:
   - Conjugative plasmids or self-transmissible plasmids
   - Nonconjugative plasmids or nontransmissible plasmids. They cannot transfer themselves.

2. Based on compatibility: Compatible plasmids and incompatible plasmids. Only compatible plasmids can stay together inside a cell.

3. Based on function:
   - Fertility (F) plasmids: Codes for sex pilus that forms the conjugation tube.
   - Resistance (R) plasmids: Contain genes that code for resistance to various antibiotics.
   - Coi plasmids: Contain genes that code for bacteriocins.
   - Virulence plasmids: Codes for virulence factors like toxins, adhesins.
   - Metabolic plasmids: They enable the host in various metabolic activities.

4. Plasmid as vector: By their ability to transfer DNA from one cell to another, plasmids have become important vectors in genetic engineering. Plasmids contain certain sites which genes can be inserted artificially by recombinant DNA technology. Such plasmids have become important vectors in genetic engineering.

Horizontal Gene Transfer in Bacteria

Gene transfer in bacteria can be broadly divided into:

- Vertical gene transfer (transmission of genes from parents to offspring)
- Horizontal gene transfer (transmission of genes from one bacterium to another bacterium). This occurs by:

Transformation

Transformation is the process of random uptake of free or naked DNA fragment from the surrounding medium by a bacterial cell and incorporation of this molecule into the chromosome in a heritable form.

- It has been studied so far only in certain bacteria: Streptococcus, Bacillus, Haemophilus, Neisseria, A melitensis and Pseudomonas.
- The Griffith experiment (1928) on mice using pneumococci strains provided the direct evidence of transformation.

Transduction

Transduction is defined as transmission of a portion of DNA from one bacterium to another by a bacteriophage.

Types of transduction:

1. Generalized transduction: It involves transfer of any part of the donor bacterial genome into the recipient bacteria.
2. Restricted or specialized transduction: Here, only a particular genetic segment of the bacterial chromosome that is present adjacent to the phage DNA is transduced.

Role of transduction:

- In addition to chromosomal DNA, transduction is also a method of transfer of episomes and plasmids.
- Drug resistance, e.g. plasmid coded penicillin resistance in staphylococci.
- Treatment: As a method of genetic engineering in the treatment of some inborn metabolic defects.

Lysogenic Conversion

During the temperate or lysogenic life cycle, the phage DNA remains integrated with the bacterial chromosome as prophage.

- The prophage acts as an additional chromosomal element which encodes for new characters to the daughter cells.

- Impacts: Phage DNA may code for various toxins abbreviated as A B C D E.

Conjugation

Conjugation refers to the transfer of genetic material from one bacterium (donor) to another bacterium (recipient or female) by mating with each other and forming the conjugation tube. It was discovered first by Lederberg and Tatum.

- F + × F- Mating: When the F+ cell (containing a plasmid called F factor or fertility factor) comes close to the F- cell (lacking F factor), the F factor forms conjugation tube, through which the F factor is transmitted to the F- cell ultimately making the F- cell into an F+ cell.

- HFr Conjugation: F factor being a plasmid, it may integrate with bacterial chromosome and behave as a plasmid.

- Such donor cells are able to transfer chromosomal DNA to recipient cells with high frequency in comparison to F and host cells, therefore, named as HFr cells (high frequency of recombination).

- During conjugation of HFr cell with an F- cell, only few chromosomal genes along with a part of the F factor get transferred. Hence, F- recipient cells do not become F+ cells.

- P' Conjugation: The conversion of an F- cell into an HFr cell is reversible.

- When the F factor reverts from the integrated to free-state, it may sometimes carry with it some chromosomal DNA from adjacent site of its attachment. This is named as P' factor (prime factor).

- When F' cell conjugates with a recipient (F-), it transfers along with the F factor, the host DNA incorporated with it. The recipient becomes F+ cell. This process is called sexduction.

- Conjugation plays a very important role in the transfer of plasmid(s) coding for antibacterial drug resistance, resistance transfer factor (RTF) and bacteriocin production (Colicinogenic (Col) factor).

- Resistance transfer factor (RTF) is the plasmid which has two components.

- Resistance factor (R) is a plasmid which has two components:

- Resistance transfer factor (RTF) is the plasmid responsible for conjugation transfer similar to F factor.

- Resistance determinant (T): Codes for resistance to one drug. An R factor can have several r determinants.

Types of Conjugation:

- F+ × F- Mating
- HFr Conjugation
- P' Conjugation
Multiple Choice Questions

**PHAGES**

9. Phage mediate transfer of \( d \text{DNA} \) into host is known as:
   a. Transduction
   b. Transformation
   c. Transfection
   d. Conjugation
   e. Fusion

**ANTIMICROBIAL RESISTANCE**

11. The mechanism of action of vancomycin is inhibition of:
   a. Cell wall synthesis
   b. RNA synthesis
   c. Cell membrane integrity
   d. Protein synthesis via 50s ribosomal subunit

12. Most common method of bacteria responsible for drug resistance:
   a. Conjugation
   b. Transduction
   c. Transformation
   d. Enzyme inactivation
   e. Mutation

13. Not true about bacterial drug resistance mechanisms:
   a. Most common mechanism is production of neutralizing enzyme
   b. If resistance is plasmid mediated, it is always transferred vertically
   c. Alteration of target seen in pneumococcal resistance
   d. Complete removal of target is cause of resistance to Vancomycin

14. Multiple drug resistance is spread by:
   a. Transformation
   b. Transduction
   c. Mutation
   d. Conjugation

15. A patient is kept on ceftriaxone and amikacin, ESBL positive Klebsiella infection.
   What will you do next?
   a. Continue with same antibiotic but in higher dose
   b. Change ceftriaxone and add ceftazidime
   c. Remove Amikacin
   d. Start imipenem in place of ceftriaxone

17. MIC (minimum inhibitory concentration) can be calculated by all of the following methods except:
   a. E test
   b. Ajay dilution method
   c. Kirby Bauer’s disk diffusion method
   d. Broth dilution method
   (Recent MCQ 2013)

18. A strain of E. coli isolated from urine is resistant to third generation cephalosporins. The mechanism of development of resistance is:
   a. Extended spectrum Beta-Lactamases
   b. Decreased permeability
   c. Active efflux of Beta-lactam agents
   d. Alteration of PBPs
   (PGI Nov 2014)

19. Beta lactamase is produced by:
   a. E.coli
   b. Gonococcus
   c. Staphylococcus aureus
   d. All of the above
   (Recent MCQ 2013)

20. Which of the following disease(s) are not toxin mediated?
   a. Diphtheria
   b. Tetanus
   c. Pertussis
   d. Anthrax
   e. Syphilis

21. A strain of E. coli isolated from urine is resistant to third generation cephalosporins. The mechanism of development of resistance is:
   a. Extended spectrum Beta-Lactamases
   b. Decreased permeability
   c. Active efflux of Beta-lactam agents
   d. Alteration of PBPs
   (PGI Nov 2014)
BACTERIAL GENETICS

1. Ans. (b) (Plasmid > transposons) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p67
   q Plasmids carry several drug resistant genes, can be transferred between bacteria through conjugation.
   q Transposons also carry certain drug resistant genes such as MEC gene of MRSA.
2. Ans. (b) (Bacterial genome) Ref: www.horizondiscovery.com
   q CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) are the sequences that contain snippets of DNA from viruses that have attacked the bacterium.
   q These fragments of DNA are used by the bacterium to detect and destroy DNA from similar viruses during subsequent infection.
   q In short, it is a prokaryotic immune system that confers the bacteria resistance to foreign genetic elements such as those present within plasmids and phages.
3. Ans. (b) (Bacteriophage) Ref: Essentials of Medical Microbiology 1/e p71
   q Transduction refers to transfer of genetic material from one bacterium to another by means of phage particles.
4. Ans. (b) (Capsulated 5. pneumovitae, non-capsulated S. pneumovitae) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p71
   q Capsulated dead S. pneumovitae is non-capsulated live S. pneumovitae.
5. Ans. (a) (Involved in Conjugational) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p67
   q Plasmids are self-replicating extrachromosomal elements freely transferred by conjugation.
6. Ans. (b) (Transduction) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p73
   q Transduction is the transfer of bacterial genes from one bacterium to another by phage particles.
   q Lytic Conduction would have been a better answer here as it is the process by which the phage DNA is integrated into bacterial DNA and remains as an integral part of bacterial DNA.
7. Ans. (c) (Conjugation) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p73, Ananthanarayan 9/e p61
   q Conjugation is the process of the transfer of free DNA from one bacterium to another.
8. Ans. (a) (Trans) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p70, Ananthanarayan 9/e p59
   q Transformation is the process where there is transfer of genetic elements from one bacterium (male) to another (female) alive, including pili or conjugation tube.
   q Horizontal genetic transfer.

ANTIMICROBIAL RESISTANCE

11. Ans. (a) (Cell wall synthesis) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p71
   q Vancomycin acts by inhibition of cell wall synthesis by binding to D-Ala-D-Ala of teetrapeptide side chain of peptidoglycan.
12. Ans. (d) (Conjugation, Enzyme inactivation) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p82-83.
   q Transferable resistance by conjugation is the most common method of transfer of bacterial resistant genes. Enzyme inactivation is the most common mechanism of bacteria drug resistance.

13. Ans. (b) (β-lactam resistance) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p67, Ananthanarayan 9/e p63, β-lactamase, Harrison 18/e p115
   q If resistance is chromosomally mediated, it is usually transferred vertically from parent to daughter bacteria.
   q If resistance is plasmid mediated, it is usually transferred horizontally by conjugation or transduction.

About Other Options
   q Clinically, enzymatic drug inactivation is the most common mechanism for acquired microbial resistance to β-lactam antibiotics.
   q Most common mechanism of bacterial drug resistance is Plasmid mediated.
   q Pneumococcal resistance is mainly due to a β-lactamase (PBP) that is resistant to Vancomycin. The complete removal of target D-Ala-D-Ala present in the bacterial cell wall is the target site for Vancomycin, which binds there and inhibits its growth and synthesis.

The four major mechanisms of antimicrobial resistance Refer chapter review.
14. Ans. (d) (Conjugation) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p73, Ananthanarayan 9/e p60-61
   q Resistance (R) factors are extrachromosomal plasmids responsible for spread of multiple drug resistance among bacteria.
   q They are circular double stranded DNA carry genes for variety of enzymes that can destroy antibiotics.
   q A factor consists of 3 components of resistance transfer factor (RTF) and resistant determinant (R).
   q The presence of RTF is responsible for conjugational transfer while each R determinant carries resistance for one of the several antibiotics.

15. Ans. (c) (Piperacillin + Tazobactam) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p60
   q ESBLs (Extended spectrum β-lactamases) are responsible for resistance to 1st and 2nd generation cephalosporins and monobactam.
   q Which can be overcome by addition of β lactamase inhibitor like clavulanic acid.

16. Ans. (c) (MecA) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p71
   q Extended Spectrum β-Lactamases (ESBLs) producing Pseudomonas can be treated with an antipseudomonal β-lactam (e.g. piperacillin) plus β-lactamase inhibitor such as tazobactam combination therapy.

17. Ans. (c) (Kirby Bauer’s disk diffusion method) Ref: Ananthanarayan 9/e p63, 16/e p630
   q Kirby Bauer’s disk diffusion method is used to test the zone of inhibition of the standard organism surrounding the disk by which we can know whether the organism is sensitive or resistant to the antibiotic disk. However, we cannot know the MIC.

18. Ans. (a) (McFarland standard) Ref: Mackie McCartyard 14/e p631-632
   q In microbiology, McFarland standards are used as an easy method to adjust the turbidity of bacterial suspensions so that the number of bacteria will be within a given range.
   q A 0.5 McFarland standard is prepared by mixing 0.05 mL of barium chloride dihydrate with 9.95 mL of 1% sulfuric acid and its equivalent to 150 million no. of bacteria/mL in a broth.

19. Ans. (d) (All of the above) Ref: Ananthanarayan 9/e p63, 233
   q Beta lactamase enzymes are plasmid coded, produced by both gram positive and gram-negative organisms.

20. Ans. (e) Syphilis Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p93
   q Syphilis is caused by T. pallidum, Refer chapter review.

21. Ans. (e) (Extended spectrum beta-Lactamases) Ref: Apurba Sastry’s Essentials of Medical Microbiology 1/e p63
   q Out of several mechanisms of beta lactam resistance in E.coli, Beta lactamases production is the MOST COMMON, particularly Extended Spectrum Beta-Lactamases (ESBL).