

Structured Notes According to MICROBIOLOGY

Revision friendly Fully Colored Book/Structured Notes

For Best results, watch the video lectures along with reading notes



© Dr. Preeti Sharma
(Author)

All rights reserved of these books are reserved under Indian Copyright Act, 1956. No part of this publication may be reproduced stored in a retrieval system or transmitted, In any form or by any means, electrical, chemical, mechanical, optical, photocopying, recording or otherwise, without the prior permission of the copyright owners.

Photocopying the whole book/uploading PDFs or images of the book without the due permission of the copyright owner is punishable under the copyright act as it weighs against the fair use policy because completely copying and distributing the work for free online and physically would hinder the economic viability of creating and maintaining the source.

Any person/ organization found doing photocopy/PDF circulation will face, strict legal actions without any prior notice.

For best result you are advised to study these books/structured notes along with Dr. Preeti Sharma's videos on PrepLadder app. For maximum gain, revision of these books/structured notes/books is being done multiple times. At the time of examination, going through- structured Notes is advisable rather than reading any reference book.

In case of any discrepancy between book and videos, Dr. Preeti Sharma's videos on PrepLadder should be considered.

The copyright of "**Microbiology Structured Notes by Dr. Preeti Sharma**" belongs to the author and any attempt to reproduce or replicate it in any form will result in a legal action without prior warning.

"The content, information provided herein are as provided and shared by the Author and have been produced on as-is basis. The Company disclaims all rights and liabilities in relation to the accuracy or correctness of the content, images or the information provided. The Author is solely responsible for, including without limitation, any claims, liabilities, damages, losses or suits that may arise with respect to the information provided herein

CONTENTS



Microbiology

UNIT 1 - GENERAL MICROBIOLOGY

1.	Scientists and Stains	4
2	Microscopes	10
3	Bacterial Anatomy	16
4	Bacterial Shapes And Physiology	27
5	Bacterial Genetics	30
6	Culture Media	39
7	Sterilization and Disinfection	53

UNIT 2 - SYSTEMIC BACTERIOLOGY

8	Staphylococcaceae	74
9	Streptococcaceae	83
10	Neisseria	94
11	Gram Positive Bacilli Part-1	98
12	Gram Positive Bacilli Part-2	107
13	Gram Positive Bacteria Part-3	123
14	Gram Negative Bacteria Part-1	135
15	Gram Negative Bacteria Part-2	144
16	Vibrio and Non Fermenters	159
17	HBB (Hemophilus, Bordetella and Brucella)	168
18	Spirochetes	177
19	Rickettsiae	187
20	Chlamydia	193
21	Miscellaneous Bacteria	196

UNIT 3 - VIROLOGY

22	Virology General Properties	211
23	DNA Virology Part-1	219
24	DNA Virology Part-2	229

25	DNA Virology Part-3	238
26	RNA Virus: Myxovirus	246
27	RNA Virus : Picornaviridae	258
28	RNA Virus : Rhabdoviridae	261
29	RNA Virus : Arbovirus	266
30	RNA Virus : Retrovirus	276
31	RNA Virus : Other RNA Viruses	286
32	RNA Virus : COVID 19	289

UNIT 4 - MYCOLOGY

33	Mycology Part-1	298
34	Mycology Part-2	323

UNIT 5 - PARASITOLOGY

35	Parasitology : Classification of Amoeba	341
36	Parasitology : Flagellates	353
37	Parasitology : Hemoflagellates	358
38	Parasitology : Coccidian Parasites	367
39	Haematozoa (Plasmodium and Babesia)	375
40	Cestodes	386
41	Trematodes	402
42	Nematodes	412

UNIT 6 - IMMUNOLOGY

43	Types of Immunity	437
44	Types of Hypersensitivity Reactions	446
45	Immunity Tolerance Autoimmune Disorders	450
46	Immunodeficiency Disorders	460
47	Transplant Immunology	464
48	Antigen and Antibody	469
49	Antigen Antibody Reactions	478

Previous Year Questions	490
--------------------------------	-----

Chanting Lines	492
-----------------------	-----



SYNOPSIS



GENERAL MICROBIOLOGY

Scientists and Stains

1. Scientist
 - 1.1 Louis Pasteur
 - 1.2 Robert Koch
 - 1.3 Paul Ehrlich
2. Stains
 - 2.1 Fixation
 - 2.2 Simple stains (one colour)
 - 2.3 Negative stains (b/w)
 - 2.4 Impregnation Stains
 - 2.5 Differential Stains**
 - 2.6 Flagella Stains
 - 2.7 Spore Stain

Good to Know

Microscopes

1. Features of Microscopes
- 2. Light Microscope**
- 3. Dark Field Microscope**
 - 3.1 Interference Contrast Microscope
4. Fluorescence Microscope
 - 4.1 Phase Contrast Microscope**
5. Electron Microscope
 - 5.1 Differences between Electron and Light Microscope

Good to Know

Must Know

Good to Know

Bacterial Anatomy

1. Capsule Layer
2. Slime Layer
3. Capsule and Slime Layer
 - 3.1 Demonstration of capsule**
 - 3.2 Modification of slime: biofilm

Good to Know

4. Cell wall

Must Know

- 4.1 Endotoxins vs exotoxins
- 4.2 Cell wall deficient forms - Lform

5. Bacterial Anatomy

- 5.1 Structure of flagella

5.2 Demonstration of motility

Good to Know

- 5.3 Spores
 - 5.4 Spore formation
- 6. Stains
 - 7. Difference between prokaryote and eukaryote

Bacterial Shapes And Physiology

- 1. Bacterial Shapes (Cocci)
- 2. Bacterial Shapes (Bacilli)

3. Bacterial Physiology

Good to Know

- 3.1 Quick Definitions: Bacterial Physiology

4. Bacterial Growth curve

Good to Know

Bacterial Genetics

- 1. Basics
- 2. Mutations
 - 2.1 Point Mutations
 - 2.2 Frame Shift mutation

3. Gene Transfer

Must Know

- 3.1 Transformation
 - 3.2 Transduction
 - 3.3 Bacteriophage Cycle
 - 3.4 Generalized Transduction
 - 3.5 Specialized/ Restricted Transduction
 - 3.6 Conjugation
- 4. Plasmids
 - 4.1 Summary
 - 5. Drug Resistance
 - 5.1 Restriction Endonucleases
 - 5.2 CRISPR-Cas9

Culture Media

1. History
2. Agar
3. Simple Media / Basal Medium / Basic Medium

4. Enriched Media

Good to Know

5. Selective Media

Must Know

- 5.1 Differential media
- 5.2 Transport Media
- 5.3 Anaerobic Media
6. Anaerobic methods 6
- 6.1 Anaerobic methods
7. Culture Technologies
- 7.1 Antibiotic Sensitivity Testing
- 7.2 Dilution method

7.3 Disc Diffusion Method or Kirby Bauer Disc Diffusion Method

Good to Know

- 7.4 Stoke's Disc Diffusion Method
- 7.5 Epsilometer Test

Sterilization and Disinfection

1. Sterilization Methods
- 1.1 Dry heat
- 1.2 Incineration

1.3 Hot Air Oven

Good to Know

- 1.4 Moist Heat: Mechanism

1.5 Below 100°

Good to Know

- 1.6 At 100°

1.7 Above 100°

Good to Know

2. Sterilization Methods: Filtration

Good to Know

3. Chemical Methods

Must Know

4. Blood Spill Management

Must Know

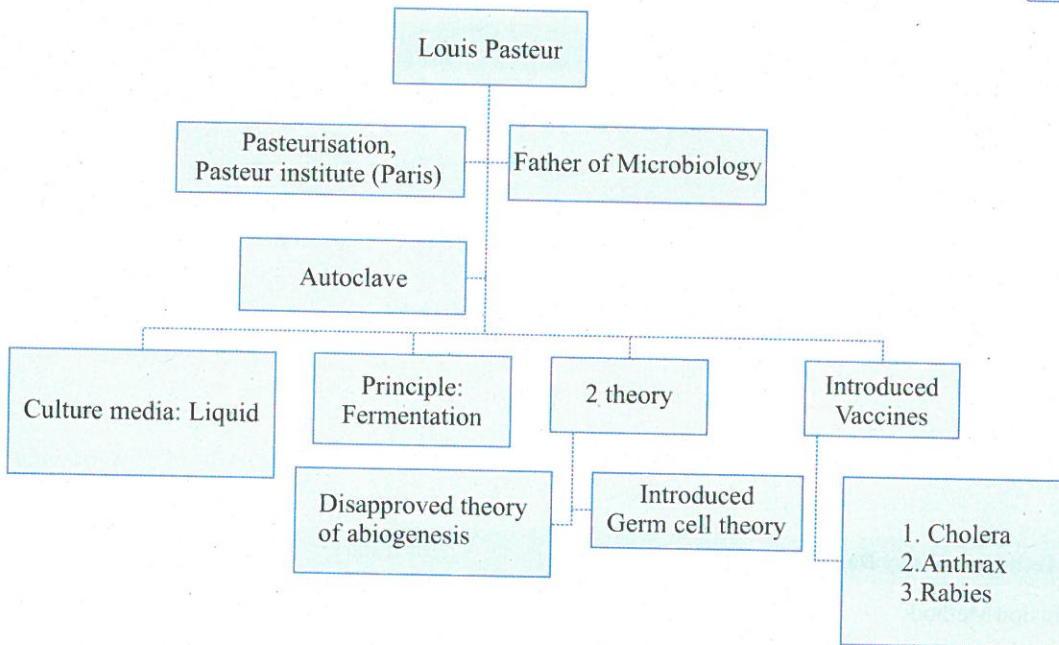
- 4.1 Other Sterilization Methods
5. Testing of Disinfectant
- 5.1 Spaulding Classification

1 SCIENTISTS AND STAINS



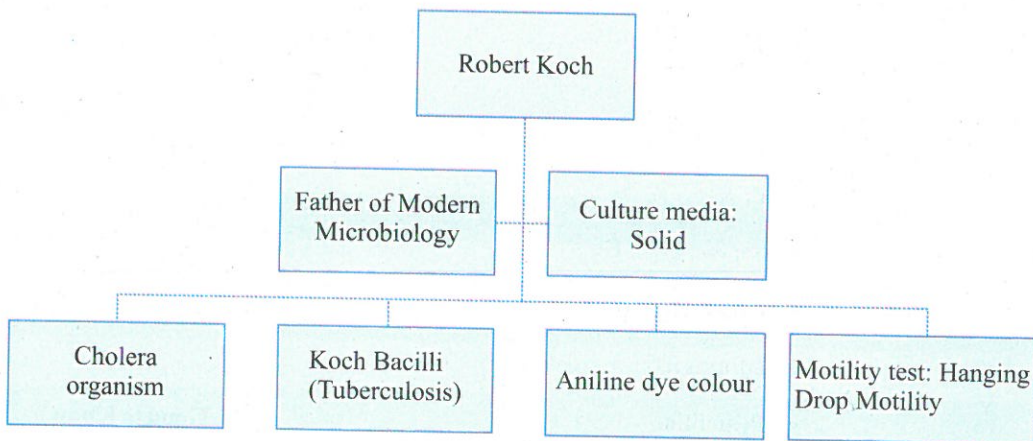
Louis Pasteur

00:01:15



Robert Koch

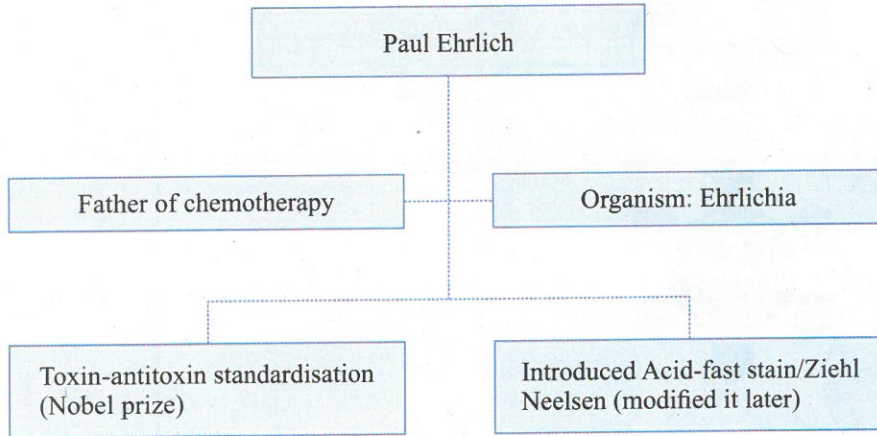
00:04:31



• Koch postulates (4+1):

- Constant association of causative organisms with the disease (Mycobacterium TB always causes tuberculosis)
- Isolation in culture media possible
- Culture growth inoculated in animals should produce the same lesion.
- Re-isolation from the experimental animals is possible.
- Whenever there is an antigen, the human should be able to produce antibodies in serum
- Exception from postulates:
 - **L-Myco**bacterium **leprae** grown in armadillo
 - **P-Treponema Pallidum**
 - **G-Gonococci**

Paul Ehrlich



Scientist	Found/Known as
Joseph Lister	<ul style="list-style-type: none"> • Father of antiseptic surgery • First used carbolic acid
Anton Von Leeuwenhoek	<ul style="list-style-type: none"> • Father of the light microscopy (Unilocular) • The first thing he visualised under his microscope was Animalcules. • Scientist: Jansen brothers invented the compound microscope (Bilocular)
Ernst Ruska	<ul style="list-style-type: none"> • Father of electron microscopy
Edward Jenner	<ul style="list-style-type: none"> • First vaccine- smallpox <ul style="list-style-type: none"> ○ Prepared using cowpox
Karry B Mullis	<ul style="list-style-type: none"> • PCR
Frederick Sanger	<ul style="list-style-type: none"> • Sanger sequencing
H C Gram	<ul style="list-style-type: none"> • Gram staining
Kleinberger	<ul style="list-style-type: none"> • L forms (cell wall deficient)
Alexander Fleming	<ul style="list-style-type: none"> • Penicillin
Barbara McClintock	<ul style="list-style-type: none"> • Transposons (Jumping genes)

Nobel prizes during Covid Era

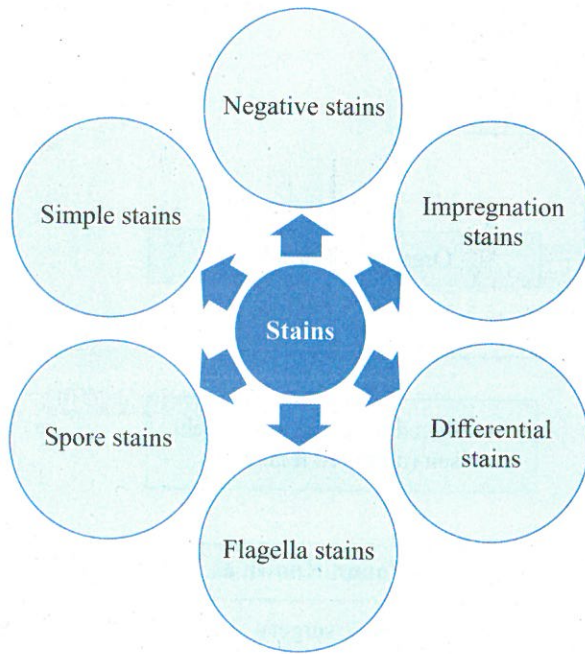
- Hepatitis C virus- Michael Houghton, Harvey J. Alter, Charles M. Rice
- CRISPR Cas9- Emmanuelle Charpentier and Jennifer A. Doudna

Stains

00:20:30

Fixation

- To ensure the sample stays on the slide
- Heat fixation
- Chemical fixation (methanol)

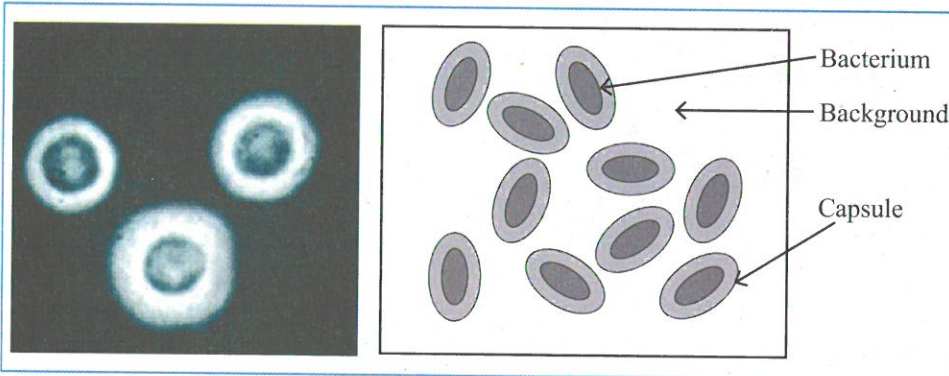


Simple stains (one colour)

- Methylene blue
- Basic fuchsin (red)

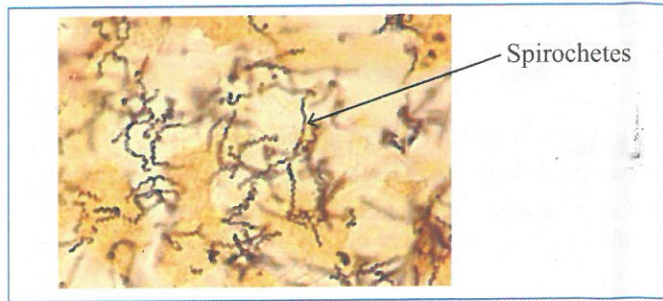
Negative stains (b/w)

- Staining the background to highlight the organisms
- Cryptococcus causes cryptococcal meningitis Sample : CSF
 - Capsulated fungi, that that doesn't take up any colour
- E.g., India ink stain, Nigrosin stain
- Nigrosin



Impregnation Stains

- Deposit stain on the surface of the object to make it look thicker.
- Silver stains- black colour
- For thin structures
 - Flagella
 - Spirochetes (Eg: Treponema caused syphilis)
 - Syphilis patient with Genital ulcers
- Fontana stain- fluid samples
- Levaditi's stain-tissue samples



Differential Stains

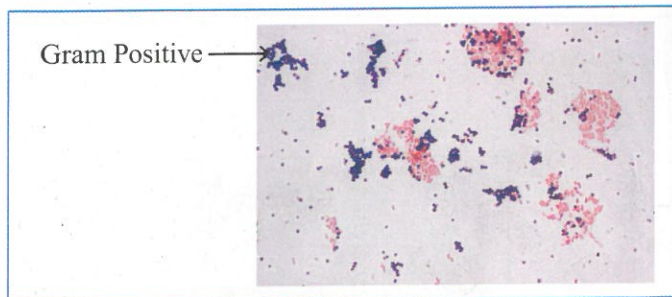
00:29:32

- Gram stain (+/-):

PYQ: AIIMS 2021

Stains	Gram +ve	Gram -ve
Crystal/ Methyl/ Gentian Violet	Purple	Purple
Iodine (Mordant)	Makes Crystal violet stick	
Alcohol/ Acetone (decolouriser most crucial step)	Purple	Colourless
Safranin	Purple	Red/Pink

- **Gram positive cell wall** contains a lot of peptidoglycans, which retain the dye longer
- **Gram-negative cell wall** contains lipopolysaccharides (LPS) making it permeable to the secondary dye after decolorization (as alcohol/acetone dissolves & washes away all the lipids in bacterial cell wall).
- Poorly gram staining: (gram stain doesn't work well)
 - Mycoplasma
 - Rickettsia
 - Chlamydia
 - Spirochetes



• Acid-fast Stain/Ziehl Neelsen Stain:

00:39:12

- Carbol Fuschin (primary stain) - red color
- Heat (mordant)
- Acid/ Acid-alcohol is added to decolorize - Sulphuric acid (most commonly)
 - **Mycobacteria- 20% H₂SO₄**
 - TB - Alcohol (95% alcohol) and Acid fast (20% H₂SO₄)
 - Atypical TB (M.avium)- Acid fast (20% H₂SO₄)
 - **Lepra- Acid Fast (5% H₂SO₄): Fite foracco stain**
 - Nocardia, Legionella- 1% H₂SO₄
 - **Coccidian parasite family- COLD ZN stain (5% H₂SO₄)**
 - Isopora, Cyclospora, Cryptosporidium

→ Spores, Head of sperm: 0.25-0.5% H₂SO₄

→ Hooklet of Hydatid

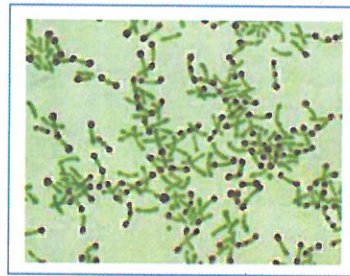
→ Eggs: Tenia Saginata

- Methylene blue or Malachite green (secondary stain) added -Background colour
- COLD ZN stain- Kinyoun Stain/Gabbet stain(modification of ZN stain)
 - Instead of heating, increase concentration of phenol in carbon fuchsin.
 - Cold ZN stain is used for the family of **coccidian parasites**

● **Albert Stain:**

00:52:58

- Albert solution 1
 - Malachite Green- Organism
 - **Toluidine blue** - stains **volutin granules** (Metachromatic stain- 2 colours)
 - Actual colour- blue
 - On sample- purple
 - Glacial Acetic acid
- Albert solution 2: Iodine
- Used for Volutin / Babes Ernt granules
 - present in C-diphtheria
 - located at 2 poles, it is also called **bipolar Granules**
 - **Metachromatic Granules-stained by Toluidine blue.**
- Stains for Volutin granules:
 - Ponder's Stain
 - Loeffler methylene Blue (best)
 - Albert Stain
 - Neisser stain
- **Volution granules also seen in Spirillum, Gardnerella, Yersinia pestis, yeast, MTB**

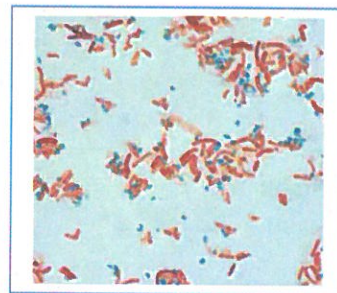


Flagella Stains

- Silver stains (impregnation method)
- Leifson and Ryu stain
 - Dye: Basic Fuchsin for flagella - Red
 - Mordant- Tannic acid
 - Dye: Methylene blue for cell - Blue

Spore Stain

- Spore- resting/ dormant form of bacteria.
- **Schaeffer and Fulton stain/ Modified Ashby stain**
 - Malachite green- spore
 - Heat- Mordant
 - Water- decolorizer
 - Safranin Red- bacteria/organism



MCQs

- Q. In Gram staining, the mordant is?
- A. Tannic acid
 - B. Loeffler's mordant
 - C. Lugol's iodine**
 - D. Bovine's fixative

Q. After the primary stain and mordant has been added but before the decolourizing agent has been used, gram-positive organisms are stained _____, and gram-negative organisms are stained _____.

- A. **Purple, Purple**
- B. Purple, colourless
- C. Purple, pink
- D. Pink, pink

Q. Metachromatic granules stained by all except?

- A. Albert stain
- B. Neisser
- C. Ponder
- D. **Kinyoun**

Q. Silver Impregnation method of staining is used to demonstrate?

- A. Mycobacteria
- B. **Spirochaetes**
- C. Both of the above
- D. None of the above

Q. Which of the following is acid-fast with 20% H₂SO₄?

- A. **M. avium**
- B. M. Leprae
- C. Actinomyces
- D. Nocardia

Q. In the ZN staining procedure, the secondary stain is?

- A. Crystal violet
- B. Safranin
- C. **Methylene blue**
- D. Alcohol

Q. Correct order of gram staining?

- A. Carbol fuchsin-iodine-Acetone-methyl violet
- B. **Crystal violet-iodine-Acetone-Safranin**
- C. Methyl violet-Acetone-iodine-Safranin
- D. Crystal violet-Carbol fuchsin-Acetone-iodine

2 MICROSCOPES



Features of Microscopes

00:00:26

- **Magnification:** Uses lens
- **Resolution:** The ability to differentiate two points as separate
 - Human eye: 0.2 mm
 - Light microscope: 0.2 micron
 - Electron microscope: 0.2-0.5 nm
- **Contrast:** Dyes

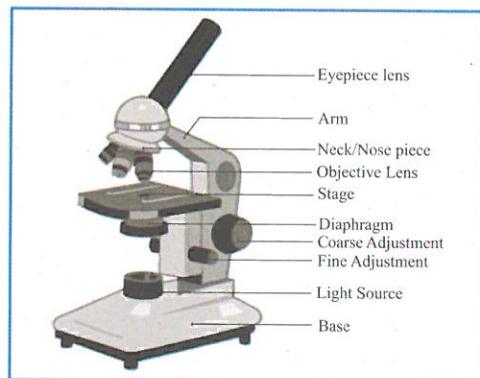
Light Microscope

00:03:06

Components of Microscope

PYQ: AIIMS 2018

- Source of Light: Transmitted light.
- **Slides are kept on Stage**
 - Light should go only to the slide through condenser (with iris/diaphragm), which regulates the light.
- The **condenser is placed below the stage.**
- Two knobs:
 - **Big knob** is for coarse adjustment
 - **Small knob** is for fine adjustment
- Two lenses
 - Eye Piece lens: 10x
 - Objective lens
 - Scanner: 4x
 - Low Power: 10x
 - High Power: 40x
 - Oil Immersion: 100x
- Lenses revolve around the neck piece

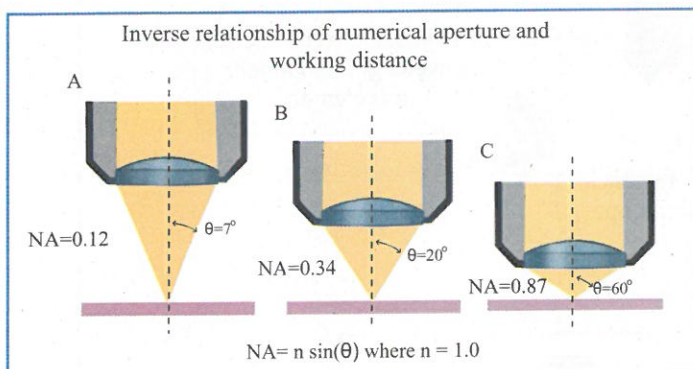


Lens	Magnification	Eyepiece	Total Magnification	Numerical Apertures
Scanner	4x	10x	40	0.12
Low Power	10x	10x	100	0.22
High Power	40x	10x	400	0.65
Oil Immersion	100x	10x	1000	1.25

Important Information

- Maximum magnification offered by light microscope is 1000x.
- As the lenses increase, numerical apertures also increase.

Numerical Aperture:



- Numerical aperture is the angle by which light falls on the slide and gets reflected.
- $NA = n (\sin \theta)$
 - Where, n is the refractive index, θ is half of the angle between the object and lens.

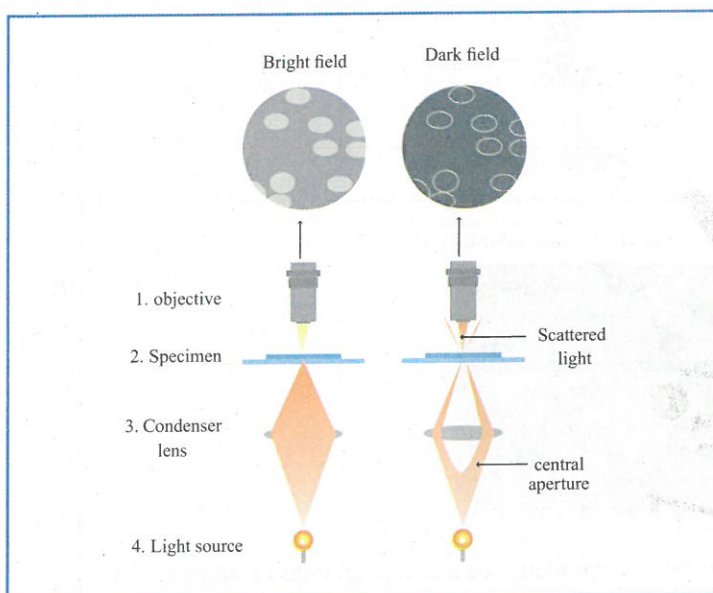
Dark Field Microscope

- Reflected Light which illuminates the objects.
- Used for Thin structure.
 - Flagella
 - Spirochetes - spiral structures

00:15:30

PYQ: FMGE 2021

PYQ: NEET PG 2021

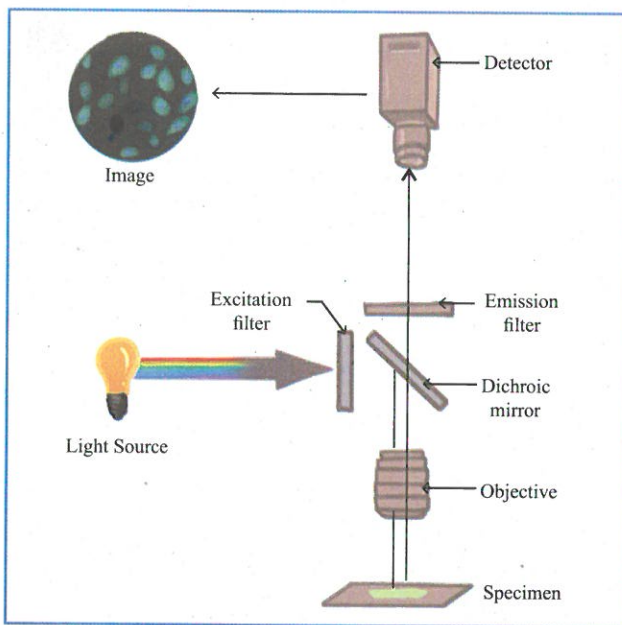
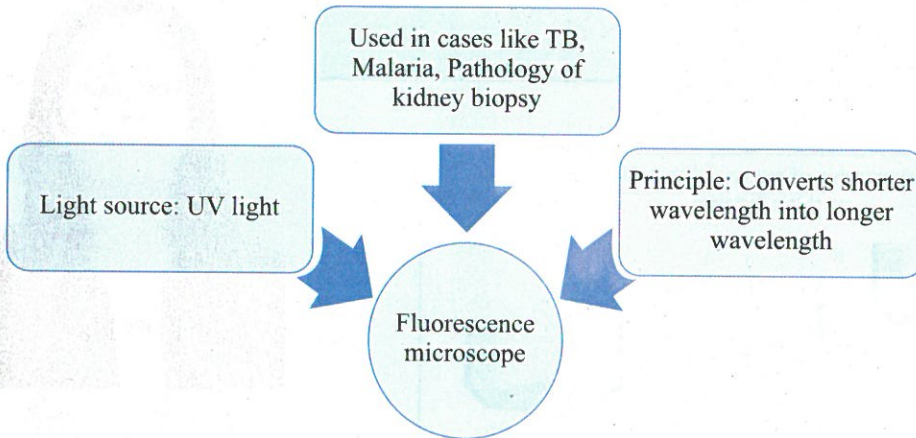


Interference Contrast Microscope

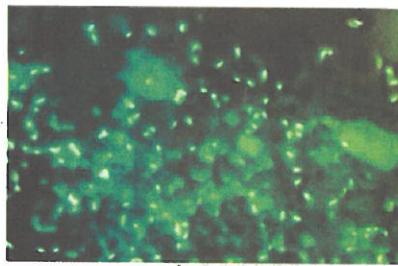
- Reveals cell organelles
- Measurements of chemical constituents of cells, such as
 - Lipids
 - Proteins
 - Nucleic acids

Fluorescence Microscope

00:18:51



MTB stained with Auramine & Rhodamine dye



- A **dichroic mirror** is used in a fluorescence microscope alongside a strong light source, an excitation filter, and an emission filter.

Autofluorescence

- Fluorescent without dye (Specimen which has their own shine, kept under UV lights)
- Spora Brothers
 - Cyclospora
 - Isospora

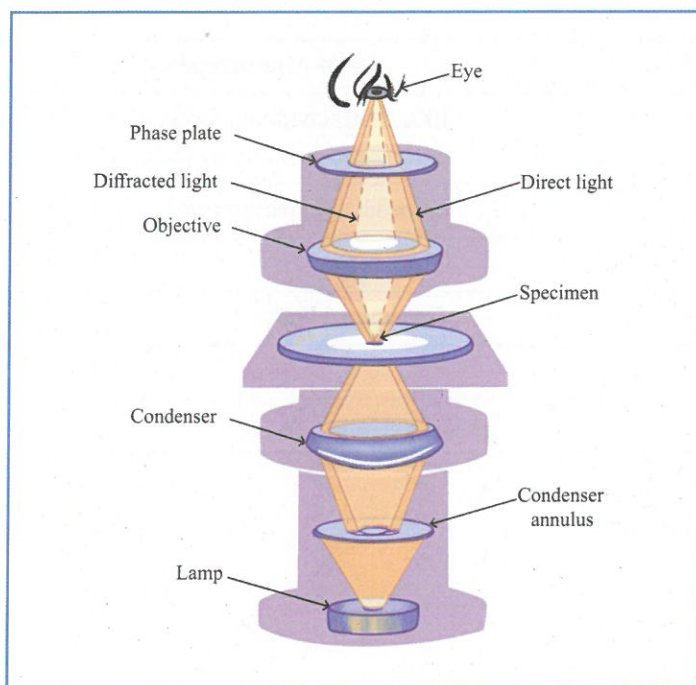
- Formalin
 - Skin biopsy for immunofluorescence in NS not formalin
- NADPH - Used in fluorescent spot test in G6PD deficiency
- Wood lamp: Ultraviolet light

Phase Contrast Microscope

00:29:38

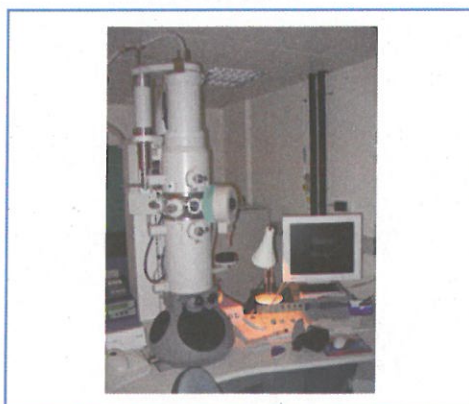
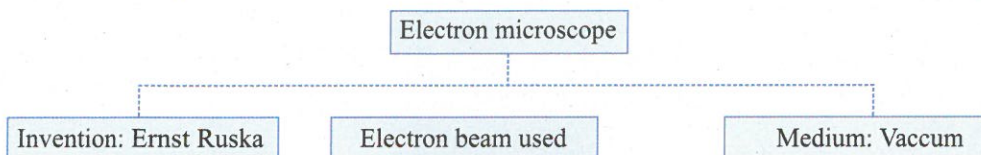
- Added at the bottom: Annular diaphragm (below the condenser)
- Added at the top: Annular phase plate
- Differences in refractive indices, it will be shown in different phases
 - Converts into a change in the amplitude of light

PYQ: AIIMS 2022



Electron Microscope

00:32:17



Types of Electron Microscope

Scanning Electron Microscope (SEM)	Features	Transmission Electron Microscope (TEM)
Scattered Electrons	Principle	Transmitted electrons
3D	Dimensional	2D
More sample viewed in lesser time	View and Time	Less sample viewed in the same time
Surface details	Details	Internal Details

Differences between Electron and Light Microscope

Electron Microscope	Features	Light Microscope
2-2.5% Glutaraldehyde	Fixation	10% neutral buffered formalin (NBF)- causes watering of eyes
Resin	Embedding	Embedding in paraffin wax
Copper metal slides	Slide	Glass slides
Electron	Source	Transmitted light
Vacuum	Medium	Air
0.5 nm	Resolution	0.2 micron

MCQs

Q. Scanning Electron Microscope is used to reveal what?

- A. **Surface structure**
- B. Internal structure
- C. Both of the above
- D. None of the above

Q. Maximum magnification strength attained by a light microscope is?

- A. 10x
- B. 40x
- C. 100x
- D. **1000x**

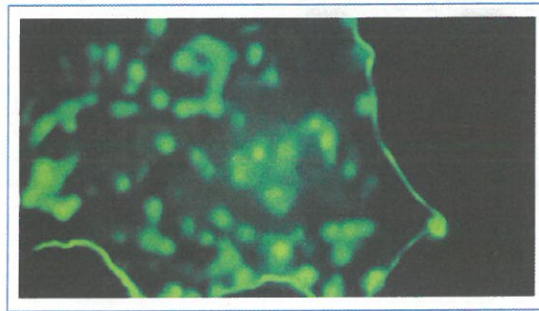
Q. In a light microscope, what function does a condenser serve?

- A. Increase light intensity
- B. **Focus the light on sample**
- C. Focus the light on the eye
- D. Reduced the glare

Q. A microscope that exposes specimens to UV LIGHT and forms an image with the emitted light at a different wavelength is called a _____ microscope?

- A. Phase-contrast
- B. Dark-field
- C. Scanning Electron
- D. **Fluorescent**

Q. Which of the following structures are required in the microscope for taking this type of image?



- A. Dark field condenser
- B. Phase plate
- C. Dichroic mirror**
- D. Cathode ray tube

Q. A microbiologist intern wanted to study cells and microorganisms. His senior advised him to use a light microscope. What is the arrangement from eye to light source in a light microscope?

- A. Objective lens ----- condenser ----- eyepiece lens
- B. Condenser lens ----- objective lens ----- eyepiece lens
- C. Eyepiece lens ----- objective lens ----- Condenser**
- D. None of the above

3 BACTERIAL ANATOMY



Capsule Layer

00:00:26

Capsule layer

Tough and demarcated
Prevents phagocytosis by preventing opsonization

Slime Layer

Slime layer

Loose and undemarcated

Capsule and Slime Layer

Bacteria has either slime or capsule layer

Exception: Only bacteria have both layers (Streptococcus salivarius)

Capsulated Organisms

Mnemonic: Pretty Nice CAPsule:

- Streptococcus Pneumonia
- Klebsiella Pneumoniae
- Bordetella Pertussis
- Vibrio Parahaemolyticus
- Clostridium Perfringens
- Yersinia Pestis -F1 peptide
- Neisseria meningococcus (Lens-shaped)
- Haemophilus Influenzae
- Cryptococcus
- Staphylococcus Aureus
- Bacillus Anthracis

All capsules are made of polysaccharides

Except:

- Yersinia pestis - F1 peptide
- Bacillus anthracis - polypeptide
- S. aureus has microcapsule
- S. pyogenes sometimes have capsule - made of hyaluronic acid

Demonstration of capsule

PYQ: FMGE 2019

McFadyen's reaction

Eg: Bacillus anthracis
Add Polychrome methylene blue stain
Turns capsule into Purple color

aka neufeld reaction

Eg: Pneumococcus
Bacteria capsule (Ag) + Antisera (Ab) =
Swelling of capsule
Antigen antibody reactions occurs