



ISBN: 978-81-950231-9-6

Editor

Dr Vijay Ramkisan Lakwal

Authors

Dr. J. Albino Wins

Dr. P.R. Janani

Dr. M. Charumathy

Dr. V. Jeyanthi Kumari

Dr. M.Poonkothai

Published By



AIB Saliha Publications, Tamilnadu, INDIA

ISBN: 978-81-950231-9-6

Handbook of MICROBIOLOGY



Editor

Dr Vijay Ramkisan Lakwal

Authors

Dr. J. Albino Wins

Dr. P.R. Janani

Dr. M. Charumathy

Dr. V. Jeyanthi Kumari

Dr. M.Poonkothai

Handbook of MICROBIOLOGY

First Edition

ISBN: 978-81-950231-9-6

Editor

Dr. Vijay Ramkisan Lakwal

Authors

Dr. J. Albino Wins

Dr. P.R. Janani

Dr. M. Charumathy

Dr. V. Jeyanthi Kumari

Dr. M. Poonkothai

Published By



AIB Saliha Publications, Tamil Nadu, INDIA.

All rights reserved. No part of this book may be reproduced or reprinted without the prior written permission of the publisher or authors.

First Edition: 2021

ISBN: 978-81-950231-9-6

**ASSOCIATION OF INDIAN BIOLOGISTS PUBLICATIONS [AIB]
(Formerly SALIHA PUBLICATIONS)**



Vaniyambadi, Tirupattur District, Tamil Nadu, INDIA

<https://salihapublications.wordpress.com/>

E. mail: salihapublications2016@gmail.com

ACKNOWLEDGMENTS

This book has been produced by Association of Indian Biologists (AIB), India. Dr. I. Niyas Ahamed, General Secretary of AIB, reviewed and deliberate the final submission including created the graphic design and layout.

EDITOR & AUTHORS PROFILE

They have sufficient teaching and research experience with expertise in Microbiology and its lab experiments. They have written this book for the benefits of undergraduate and postgraduate students.

Editor	Dr Vijay Ramkisan Lakwal Assistant Professor, Department of Zoology, Nanasaheb Yashwantrao Narayanrao Chavan Arts, Science and Commerce College Chalisgaon, Jalgaon, Maharashtra. Email: vijaylakwal02@gmail.com
---------------	---

Chapter No	Author's Profile
1.	<p>Dr. M. POONKOTHAI Assistant Professor (SG) Department of Zoology Avinashilingam Institute for Home Science and Higher Education for Women Coimbatore -43, Tamil Nadu Email: poonkothaiadu@gmail.com</p>
2.	<p>Ms. V. JEYANTHI KUMARI Assistant Professor of Zoology, A.P.C.Mahalaxmi College for Women, Thoothukudi, Tamil Nadu Email: jeyanthikumari@apcmcollege.ac.in</p>

3.	<p style="text-align: center;">Dr.M. Charumathy. Assistant Professor Department of Biochemistry Marudhar Kesari Jain College for Women Vaniyambadi Tirupattur, Tamil Nadu E. mail: mcharumathy4@gmail.com</p>
4	<p style="text-align: center;">Dr. J. Albino Wins, Assistant Professor, Department of Botany, Holy Cross College (Autonomous), Nagercoil -4 Kanyakumari District, South India. E.mail : winsbt@gmail.com</p>
5.	<p style="text-align: center;">Dr. Janani P R. Laboratory Authorization & Thesis Assistant Salem Diagnostic Reference Laboratory Salem, Tamil Nadu. Email: jananimicrobiology@gmail.com</p>

PREFACE

The first edition of “Handbook of Microbiology” this book was written to help students to learn about Microbial science.

Microbiology is the study of microscopic organisms, such as bacteria, viruses, archaea, fungi and protozoa. This discipline includes fundamental research on the biochemistry, physiology, cell biology, ecology, evolution and clinical aspects of microorganisms, including the host response to these agents.

We welcome comments by readers of “Handbook of Microbiology” for ways to improve the book and to increase its value. Such suggestions will be seriously considered in the preparation of subsequent editions.

CHAPTER NO	CONTENTS	PAGE NO
1	STRUCTURE AND CLASSIFICATION Structure and classification of virus, bacteria and fungi.	1-79
2	STERILIZATION AND CULTURE Sterilization: Principles - dry heat, moist heat, filtration, Tantalization, pasteurization, Radiation - disinfection. Culture techniques - media preparation - Aerobic and anaerobic culture techniques - Wet mount, hanging drop, staining methods, dyes, simple differential and special staining techniques - acid fast stain, spore stain, capsule stain, staining for pure and mixed cultures.	80-147

3	ENVIRONMENTAL MICROBIOLOGY Microbial ecology, role of microorganisms in the productivity of ecosystems - Interactions between microorganisms and plants and animal. Microbiology of soil, water and air.	148-217
4	MEDICAL MICROBIOLOGY Pathogenic microbes of bacterial, viral, fungal and protozoan diseases – cure, control and prevention. Antimicrobial chemotherapy - Antibiotics - Source – Classification	218-279
5	INDUSTRIAL MICROBIOLOGY Industrial microbiology - Industrial uses of microbes - fermentation products,	

	<p>bioconversions - bioremediation.</p> <p>Products of industrial microbiology</p> <p>- Penicillin, fuel ethanol, vinegar, vitamin B12, citric acid, glutamic acid, protease. Food and Dairy microbiology - Microbes in food - Role of microbes in food production. Dairy and non-dairy products - fermented foods and alcoholic beverages.</p> <p>Pharmaceuticals (antibiotics, vaccines etc.)</p>	280-376
--	---	---------

CHAPTER-IV

MEDICAL MICROBIOLOGY

Pathogenic microbes of bacterial, viral, fungal and protozoan diseases – cure, control and prevention. Antimicrobial chemotherapy - Antibiotics - Source – Classification

Dr.M.Charumathy.

Assistant Professor

Department of Biochemistry

MarudharKesari Jain College for Women

Vaniyambadi

Thirupattur, Tamil Nadu

E.mail: mcharumathy4@gmail.com

PATHOGENIC BACTERIA:

Bacterial diseases include any type of illness caused by bacteria. Bacteria are a type of microorganism, which are tiny forms of life that can only be seen with a microscope. Other types of microorganisms include viruses, some fungi, and some parasites.

Millions of bacteria normally live on the skin, in the intestines, and on the genitalia. The vast majority of bacteria do not cause disease, and many bacteria are actually helpful and even necessary for good health. These bacteria are sometimes referred to as “good bacteria” or “healthy bacteria.”

Harmful bacteria that cause bacterial infections and disease are called pathogenic bacteria. Bacterial diseases occur when pathogenic bacteria get into the body and begin to reproduce and crowd out healthy bacteria, or to grow in tissues that are normally sterile. Harmful bacteria may

also emit toxins that damage the body. Common pathogenic bacteria and the types of bacterial diseases they cause include:

- *Escherichia coli* and *Salmonella* cause food poisoning.
- *Helicobacter pylori* cause gastritis and ulcers.
- *Neisseria gonorrhoeae* causes the sexually transmitted disease gonorrhea.
- *Neisseria meningitidis* causes meningitis.
- *Staphylococcus aureus* causes a variety of infections in the body, including boils, cellulitis, abscesses, wound infections, toxic shock syndrome, pneumonia, and food poisoning.
- *Streptococcal bacteria* cause a variety of infections in the body, including pneumonia, meningitis, ear infections, and strep throat.

Bacterial diseases are contagious and can result in many serious or life-threatening complications,

such as blood poisoning (bacteremia), kidney failure, and toxic shock syndrome.

SYMPTOMS:

Symptoms of bacterial diseases vary depending on the type of bacterial infection, the area of the body that is infected, and other factors, such as the patient's age and health history. The symptoms of bacterial diseases can also resemble symptoms of other diseases, such as colitis, influenza, and viral infections. The classic symptom of a bacterial infection is a fever, although not all people with a bacterial infection will have a fever.

Bacterial disease symptoms can include:

- Bloody urine and painful, frequent urination
- Diarrhea
- Flu-like symptoms (fatigue, fever, sore throat, headache, cough, aches and pains)
- Irritability
- Nausea and vomiting

- Pain such as joint, ear or abdominal pain
- Rashes, lesions and abscesses
- Stiff neck
- Weakness

In infants, signs of a bacterial disease can also include:

- Bulging of the soft spot on the top of the head
- Difficulty with feeding
- Excessive crying or fussiness
- Excessive sleepiness

SERIOUS SYMPTOMS INDICATES A LIFE-THREATENING CONDITION:

- Confusion or delirium
- Deep, wet chest cough that produces yellow, green or brownish phlegm
- Difficulty breathing, wheezing or shortness of breath

- High fever (higher than 101 degrees)
- Inappropriate change in alertness or level of consciousness
- Infants: sunken fontanel (soft spot) on the top of the head, lethargy, no tears with crying, and few or no wet diapers
- Lethargy or unresponsiveness
- Not urinating or urinating small amounts of tea-colored urine
- Seizure

CAUSES:

Bacterial diseases are caused by harmful bacteria (pathogenic bacteria). The vast majority of bacteria do not cause disease, and many bacteria are actually helpful and even necessary for good health. Bacterial diseases occur when pathogenic bacteria get into an area of the body that is normally sterile, such as the bladder, or when they crowd out the helpful bacteria in places such as the intestines, vagina or mouth. Less common,

bacterial infections can occur when healthy bacteria multiply uncontrollably.

VARIOUS WAYS PATHOGENIC BACTERIA CAN ENTER THE BODY:

Pathogenic bacteria can enter the body through a variety of means including:

- Contamination of bites, cuts, rashes, abrasions and other breaks in the skin, gums and tissues
- Eating contaminated food
- Getting bitten by an infected insect
- Inhaling contaminated air-borne droplets into the nose and lungs
- Kissing an infected person
- Sharing needles for tattooing or drug use
- Through the eyes, ears or urethra
- Touching infected feces or body fluids, and not washing your hands before eating or touching your mouth, eyes or nose

Once bacteria enter the body, a healthy immune system will recognize the bacteria as foreign invaders and try to kill or stop the bacteria from reproducing. However, even in a healthy person, the body is not always able to stop the bacteria from multiplying and spreading. As the harmful bacteria reproduce, they can crowd out healthy bacteria and microorganisms and emit toxins that damage the cells of the body.

THE RISK FACTORS FOR BACTERIAL DISEASES:

Bacterial diseases can occur in any age group or population, but a number of factors increase the risk of developing bacterial diseases. Not all people with risk factors will get bacterial diseases. Risk factors for bacterial diseases include:

- Being an infant, child or older adult
- Eating eggs or meats that are raw or undercooked

- Eating expired foods, or eating leftovers that have been stored for more than two to three days
- Having a genetic predisposition to bacterial infection
- Having a compromised immune system due to an immunodeficiency disorder, HIV/AIDS, diabetes, cancer or cancer treatment, kidney disease, or from taking steroid medications
- Having a chronic disease
- Malnutrition
- Not washing your hands frequently, especially after using the bathroom, touching pet feces, handling reptiles, or touching raw foods or foods contaminated with bacteria
- Significant exposure to a person with a bacterial disease

REDUCING YOUR RISK OF BACTERIAL DISEASES:

You can lower your risk of developing or transmitting bacterial diseases by :

- Avoiding contact with a person who has a bacterial disease or its symptoms, such as fever, vomiting or diarrhoea
- Covering your mouth and nose with a tissue when sneezing or coughing, then washing your hands
- Defrosting foods in the refrigerator or microwave, not on the counter
- Refrigerating leftovers right away and eating them within two to three days unless they have been frozen
- Eating a healthy diet that is high in whole grains, fruits and vegetables and contains adequate low-fat protein and low-fat dairy products or other calcium sources
- Getting enough rest and minimizing stress

- Getting recommended vaccines for bacterial diseases, such as meningitis, pneumonia, tetanus and rabies
- Seeking regular medical care and following your treatment plan for a chronic disease
- Throwing out expired food or perishable food that has been sitting at room temperature for two hours or longer
- Using antibacterial products to clean surfaces, such as computer keyboards, telephones and sinks
- Washing your hands after using the bathroom and after contact with pet feces, reptiles, dirty diapers, raw foods, and people who are ill
- Washing plates, utensils, and cutting boards that have been exposed to raw meats or poultry in hot soapy water
- Wearing long pants and sleeves, and using insect repellent when in tall grass or wooded areas

TREATMENT:

Bacterial diseases are treated with antibiotics. Antibiotics work by killing the harmful bacteria or by stopping them from reproducing and spreading. Different types of antibiotics are effective for treating specific types of bacteria. Antibiotics may be given orally, intravenously, or by intramuscular injection, depending on the type and severity of bacterial disease and other factors.

General types of antibiotics include:

- Aminoglycosides
- Cephalosporins
- Macrolides
- Penicillins
- Quinolones
- Tetracyclines

Treatment of bacterial infections also includes:

- Good nutrition

- Hospitalization and intensive care in some cases, especially if complications occur
- Increased fluids
- Rest

People who have had close contact with a person with a serious bacterial disease, such as bacterial meningitis, may also need to be treated and monitored for the disease, even in the absence of symptoms.

Sometimes an antibiotic that used to work in treating a bacterial disease stops being effective. This is called antibiotic resistance. This makes a bacterial disease more difficult to treat and can result in serious complications, such as sepsis, coma and death.

COMPLICATIONS OF BACTERIAL DISEASES:

In some people, bacterial diseases can lead to serious, even life-threatening complications. Therefore, it is important to visit your health care provider when you experience symptoms of a

bacterial infection. Once the underlying infection has been determined, following the treatment plan outlined by your doctor can help reduce any potential complications including:

- Coma
- Kidney failure
- Septicemia, which is a life-threatening blood infection that can lead to a body-wide response called sepsis
- Severe dehydration and electrolyte imbalance
- Shock
- Toxic shock syndrome

PATHOGENIC VIRUS:

Viral diseases are extremely widespread infections caused by viruses, a type of microorganism. There are many types of viruses that cause a wide variety of viral diseases. The most common type of viral disease is the common cold, which is caused by a viral infection of the upper respiratory tract (nose and throat). Other common viral diseases include:

- Chickenpox
- Flu (influenza)
- Herpes
- Human immunodeficiency virus (HIV/AIDS)
- Human papillomavirus (HPV)
- Infectious mononucleosis
- Mumps, measles and rubella
- Shingles
- Viral gastroenteritis (stomach flu)
- Viral hepatitis
- Viral meningitis
- Viral pneumonia

Viral diseases are contagious and spread from person to person when a virus enters the body and begins to multiply. Common ways that viruses spread from person to person include:

- Breathing in air-borne droplets contaminated with a virus

- Eating food or drinking water contaminated with a virus
- Indirect transmission from person to person by a virus host, such as a mosquito, tick, or field mouse
- Touching surfaces or body fluids contaminated with a virus

Viral diseases result in a wide variety of symptoms that vary in character and severity depending on the type of viral infection and other factors, including the person's age and overall health. Common symptoms of viral diseases include flu-like symptoms and malaise.

Viral diseases are not treatable with antibiotics, which can only cure bacterial diseases and infections. However, the most common viral diseases, the common cold and the flu, are self-limiting in generally healthy people. This means that the viral infection causes illness for a period of time, then it resolves and symptoms disappear

as your immune system attacks the virus and your body recovers.

In some cases, viral diseases can lead to serious, possibly life-threatening complications, such as dehydration, bacterial pneumonia, and other secondary bacterial infections. People at risk for complications include those who have a chronic disease or a suppressed or compromised immune system, and the very young and very old. In addition, certain types of sexually transmitted viral infections, such as HIV/AIDS and HPV, can lead to serious complications and death.

SYMPTOMS OF VIRAL DISEASES:

Symptoms of viral diseases vary depending on the specific type of virus causing infection, the area of the body that is infected, the age and health history of the patient, and other factors. The symptoms of viral diseases can affect almost any area of the body or body system. Symptoms of viral diseases can include:

- Flu-like symptoms (fatigue, fever, sore throat, headache, cough, aches and pains)
- Gastrointestinal disturbances, such as diarrhoea, nausea and vomiting
- Irritability
- Malaise (general ill feeling)
- Rash
- Sneezing
- Stuffy nose, nasal congestion, runny nose, or postnasal drip
- Swollen lymph nodes
- Swollen tonsils
- Unexplained weight loss

In infants, signs of a viral disease can also include:

- Bulging of the soft spot on the top of the head
- Difficulty with feeding
- Excessive crying or fussiness

- Excessive sleepiness

SERIOUS SYMPTOMS INDICATES A LIFE-THREATENING CONDITION:

In some cases, viral diseases can result in serious complications, such as dehydration or pneumonia.

- Change in alertness or level of consciousness
- Chest pain
- Deep, wet chest cough that produces yellow, green or brownish phlegm
- High fever (higher than 101 degrees Fahrenheit)
- Lethargy or unresponsiveness
- Seizure
- Shortness of breath, wheezing, or difficulty breathing
- Stiff neck
- Yellowing of the skin and whites of the eyes (jaundice)

CAUSES:

Viral infections occur when a virus enters the body and invades the inside of the body's cells in order to reproduce. If the body's immune system is unable to fight off the virus, it multiplies and spreads to other cells, repeating the process and leading to a widespread infection.

TYPES OF VIRUSES

There are many types of viruses that cause a wide variety of viral infections or viral diseases. In fact, there are more than 200 different viruses that can cause a cold or an upper respiratory infection. Other common viruses include the following:

- Epstein-Barrvirus causes infectious mononucleosis (cytomegalovirus causes a very similar disease in some people).
- Human immunodeficiency virus (HIV) causes AIDS.

- Human papillomaviruses (HPV) cause HPV infection, cervical dysplasia, genital warts, and cervical cancer.
- Influenza viruses, such as H1N1, cause influenza (flu).
- Respiratory syncytial virus (RSV) causes lower respiratory tract infections in young children.
- Rhinoviruses cause the common cold.
- Rotavirus, enteroviruses and noroviruses cause viral gastroenteritis.
- Varicella zoster virus causes shingles and chickenpox.
- West Nile virus causes West Nile fever.

VARIOUS WAYS TO INFECTED WITH A VIRUS:

You can catch a virus in a variety of ways including:

- Being bitten by an animal infected with a virus
- Being bitten by an insect infected with a virus, such as with West Nile virus

- Breathing in air-borne droplets contaminated with a virus
- Eating food or drinking water contaminated with a virus
- Sharing needles for tattooing or drug use with an infected person
- Touching infected feces or body fluids and not washing your hands before eating or touching your mouth, eyes or nose
- Touching surfaces contaminated with a virus
- Transmission of a virus from an infected mother to her baby during pregnancy or delivery

RISK FACTORS FOR CONTRACTING VIRAL DISEASES:

Viral diseases can occur in any age group or population. Everybody contracts viral diseases during their life, although in some cases, the virus does not cause obvious symptoms. Risk factors for

catching a viral disease or developing complications of a viral disease include:

- Advanced age
- Compromised immune system due to an immunodeficiency disorder, HIV/AIDS, cancer or cancer treatment, kidney disease, or other condition
- History of chronic disease, such as asthma, COPD, diabetes, tuberculosis, or heart disease
- Malnourishment
- Not getting enough rest and having high levels of stress
- Not washing your hands frequently, especially before eating or after using the restroom, or after touching common surfaces
- Sharing needles to inject drugs or for tattooing
- Young age including infancy and elementary-school-age children

REDUCING YOUR RISK OF VIRAL DISEASES:

You can lower your risk of catching or spreading a viral disease by:

- Avoiding contact of your hands with your eyes, nose and mouth, which can transmit a virus into the body
- Avoiding contact with a person who has a viral disease
- Covering your mouth and nose with your elbow (not your hand) or a tissue when sneezing or coughing
- Eating a well-balanced diet that includes sufficient amounts of fruits and vegetables
- Sufficient rest
- Using a sterile, unused needle for each act of tattooing or injectable drug use
- Using appropriate antibacterial cleaners to clean your hands and surfaces

- Vaccination as recommended by your health care provider for viral diseases, such as chickenpox, shingles, influenza, HPV, hepatitis B, hepatitis A, measles, and mumps
- Washing your hands with soap and water for at least 15 seconds after contact with a person who has a viral disease, before eating, or after using the restroom or touching feces, body fluids, surfaces, or foods that are potentially contaminated with viruses

TREATMENT:

Treatment of viral infections varies depending on the specific virus and other factors. General treatment measures are aimed at relieving your symptoms so that you can get the rest you need to keep up your strength and recover without developing complications.

General treatments for viral infections include:

- Acetaminophen (Tylenol) or ibuprofen (Motrin, Advil) for fever, body aches, and pain
- Drinking extra fluids
- Getting extra rest and sleep
- Maintaining good nutrition

MEDICATIONS USED TO TREAT VIRAL DISEASES:

In some cases, certain medications may be prescribed to treat viral diseases:

- Antiretroviral medications, which can help people with HIV/AIDS lead longer lives. Antiretroviral medications hinder the ability of HIV to reproduce, which slows the spread of HIV in the body.
- Antiviral drugs, which minimize the severity and length of some viral infections, such as the flu and shingles, especially in people who are at a high risk for serious complications. For example, the drugs oseltamivir (brand name Tamiflu) and zanamivir (brand name

Relenza) may be prescribed for some cases of flu. These drugs are not appropriate for all people with the flu.

Antibiotics, which are not prescribed for viral diseases because they are ineffective in the treatment of viral infections, may be prescribed if a person with a viral disease develops a secondary bacterial infection, such as bacterial pneumonia, bacterial bronchitis, or encephalitis.

COMPLEMENTARY TREATMENTS:

Complementary and traditional treatments will not cure a viral disease but may help to increase comfort, promote rest, and minimize symptoms of viral diseases. Some possible treatments include:

- Chicken soup to help break up congestion and provide easy-to-digest nutrients and extra fluids to help keep up strength
- Supplements or products that contain vitamin C, echinacea, or zinc
- Using a vaporizer

- Using mentholated ointments on the chest

COMPLICATIONS OF VIRAL DISEASES:

In some people, viral diseases can break down the body's defenses and lead to more serious infections and life-threatening complications. Therefore, it is important to visit your health care provider when you have symptoms of a viral infection. Once the underlying infection has been determined, following the treatment plan outlined by your health care provider can help reduce any potential complications including:

- Acute bronchitis
- Cervical cancer (from human papillomavirus infection)
- Dehydration
- Frequent life-threatening, opportunistic infections
- Otitis media (ear infection)
- Pneumonia

- Secondary bacterial infection
- Seizures
- Shock and coma
- Sinusitis
- Worsening of asthma

PATHOGENIC FUNGAL INFECTION:

Fungal infections can affect anyone, and they can appear on several parts of the body. A jock with athlete's foot and a baby with thrush are just a few examples.

Fungi are microorganisms characterized by a substance in their cell walls called chitin. Some fungi, like many types of mushrooms, are edible. Other types of fungi, like *aspergillus*, can be extremely dangerous and lead to life-threatening diseases. Different types of fungi can cause fungal infections. In some cases, fungi that aren't typically found on or inside your body can colonize

it and cause an infection. In other cases, fungi that are normally present on or inside your body can multiply out of control and cause an infection.

Fungal infections can be contagious. They can spread from one person to another. In some cases, you can also catch disease-causing fungi from infected animals or contaminated soil or surfaces.

COMMON TYPES:

A fungal infection is also known as mycosis. Although most fungi are harmless to humans, some of them are capable of causing diseases under specific conditions. Fungi reproduce by releasing spores that can be picked up by direct contact or even inhaled. That's why fungal infections are most likely to affect your skin, nails, or lungs. Fungi can also penetrate your skin, affect your organs, and cause a body-wide systemic infection.

Some common types of fungal infection include:

- athlete's foot

- jock itch
- ringworm
- yeast infection
- onychomycosis, or a fungal infection of the nail

Some types of fungi don't normally cause infections in humans but can cause sickness in people with weakened immune systems. These are called opportunistic infections.

ATHLETE'S FOOT:

Athlete's foot is also known as *tinea pedis*. It's a type of fungal infection that can affect the skin on the feet, as well as hands and nails. The infection is caused by dermatophytes, a group of fungi that can thrive in the warm and humid areas between toes.

It's particularly common among athletes and can spread from one person to another. It also catches from contaminated surfaces, like a public shower or locker room floors.

SYMPTOMS

Athlete's foot can cause an itching, stinging, or burning sensation between toes or on other parts of the foot. The skin might also crack, peel, or blister.

TREATMENT:

There are several topical over-the-counter (OTC) antifungal medications can use to treat athlete's foot.

RINGWORM

Ringworm is a fungal infection that can affect the skin and scalp. Similar to athlete's foot, it's caused by dermatophytes. Ringworm is also part of a group of fungi that grow on skin, particularly in damp and humid parts of the body.

SYMPTOMS

It usually starts as a reddish, itchy, scaly rash. Over time, patches of ringworm can spread and form red rings.

Other signs include:

- Patches that get blisters and start to ooze
- Bald patches on the scalp
- Patches that look like rings with a redder outside edge
- Thick, discolored, or cracked nails (if the infection is in the nails)

TREATMENT

Like athlete's foot, ringworm is often able to be successfully treated with OTC antifungal creams, sprays, gels, or ointments.

YEAST INFECTION:

Candida albicans is a type of fungus that can infect your skin, mouth, gastrointestinal tract, urinary tract, or genitals.

It's normal for small amounts of candida albicans to be present on the skin and in the body. But when these fungi multiply too much, they can cause an infection known as a yeast infection.

SYMPTOMS

If the yeast infection in the throat or mouth, it's called oral thrush. Thrush causes white patches to form in the mouth and throat. People who undergo prolonged antibiotic therapy often develop this type of infection.

In women, vaginal yeast infections are relatively common. They can cause:

- Pain
- Itchiness
- Clumpy discharge
- Swelling
- Redness

TREATMENT

The treatment options will depend on the type of yeast infection. Thrush can be treated with oral antifungal medications. These can come in the form of lozenges, pills, or mouthwash.

TOENAIL FUNGUS:

Onychomycosis is a common type of fungal infection that can affect the toenails, fingernails, and nail beds. It's also known as tineaunguium.

SYMPTOMS

Toenail fungus usually starts as a small light-colored spot on the nail. As it spreads deeper, it changes the shape and color of your nail. Over time, it can cause your nail to become thicker and more brittle.

Common signs include:

- Scaling under the nail
- White or yellow streaks under the nail
- Flakiness or crumbling of the nail
- Thick or brittle nail
- Lifting off the nail bed

TREATMENT

It can potentially take weeks to treat fingernail infections and months to treat toenail infections.

OTC medications typically aren't effective. A nail lacquer that's brushed on like nail polish or an antibiotic taken by mouth.

PATHOGENIC PROTOZOA:

Protozoa are single-celled organisms classified as eukaryotes (organisms whose cells contain membrane-bound organelles and nuclei). Other eukaryotes include:

- Humans
- Other animals
- Plants
- Algae
- Helminths
- Fungi

Protozoa are found everywhere. They can live on their own as free-living organisms in the environment, often in the soil, water, or moss. They can also be resting cysts, which lets them survive through dry times.

Some protozoa are parasites. Others live in symbiosis with other organisms, each relying on the other for survival.

Protozoa are broken down into different classes:

- Sporozoa (intracellular parasites)
- Flagellates (with tail-like structures that flap around to move them)
- Amoeba (which move using temporary cell body projections called pseudopods)
- Ciliates (which move by beating multiple hair-like structures called cilia)

Infections caused by protozoa can be spread through ingestion of cysts (the dormant life stage), sexual transmission, or through insect vectors.

Many common—and not so common—infections are caused by protozoa. Some of these infections cause illness in millions of people each year; other infections are rare and may be disappearing.

PROTOZOAN DISEASES:

Common infectious diseases caused by protozoans include:

- Malaria
- Giardia
- Toxoplasmosis

These infections are found in very different parts of the body. Malaria infections start in the blood, giardia starts in the gut, and toxoplasmosis can be found in lymph nodes, the eye, and also (worrisomely) the brain.

Other protozoan disease includes:

- **African trypanosomiasis ("sleeping sickness"):** Caused by *Trypanosomabruceigambiense* (98% of cases) and *Trypanosomabruceirhodesiense* (2%). Both are spread by tsetse fly bites.¹
- **Amoebic dysentery:** Due to *Entamoebahistolytica*),² which causes diarrhea and GI upset. It can also travel

through the walls of the intestines and go into the bloodstream and on to other organs, like the liver, where it can create liver abscesses.

TREATMENT:

Treatment options depend on what protozoa are infecting you. Some are a lot more successful than others.

Malaria is a common illness worldwide that has straightforward treatment, though the treatment depends on the type of malaria (*Plasmodium falciparum*, *Plasmodium knowlesi*, *Plasmodium malariae*, *Plasmodium ovale*, and *Plasmodium vivax*).

Treatment also depends on whether the protozoa is drug resistant. *P. falciparum* especially has grown resistant to some important drugs over the last few decades.

DETECTING INFECTIONS:

Unlike other pathogens, samples with protozoa cannot be simply identified through a culture. Sometimes they can be seen under a microscope, whether inside of red blood cells (as in malaria) or in stool (as in giardia and *E. histolytica*).

There are also rapid blood tests for antibodies or antigens, as well as PCR tests that detect their genetic material.

TOXOPLASMOSIS

Toxoplasmosis can be identified in a number of different ways depending on where it's causing an infection, including:

- Antibody blood tests
- PCR tests
- Special stains of tissue
- Direct isolation of the pathogen

GIARDIA

Giardia can be found through an antigen test of the stool and also by looking at the stool under a microscope. It may take multiple stool samples (maybe three) to diagnose this.

ENTAMOEBA HISTOLYTICA

E. histolytica can also be identified from stool samples like Giardia. It may be identified under a microscope, through a PCR test, antigen test, or through an antibody test of the blood.

ANTIMICROBIAL CHEMOTHERAPY

Chemotherapy is a treatment of a disease by a chemical compound selectively directed against invading microbes or abnormal cells

Antibiotic is a microbial product or its derivative that kills or inhibits growth of a susceptible organism

Antimicrobial is any agent that kills or inhibits growth of a susceptible organism

Antimicrobial chemotherapy is the clinical application of antimicrobial agents to treat infectious disease.

There are five types of antimicrobial chemotherapy:

- Antibacterial chemotherapy, the use of antibacterial drugs to treat bacterial infections
- Antifungal chemotherapy, the use of antifungal drugs to treat fungal infections
- Anthelmintic chemotherapy, the use of anthelmintic drugs to treat worm infections
- Antiprotozoal chemotherapy, the use of antiprotozoal drugs to treat protozoan infections
- Antiviral chemotherapy, the use of antiviral drugs to treat viral infections

ANTIBIOTICS - SOURCE & CLASSIFICATION:

Antibiotics (Greek anti, “against”; bios, “life”) are chemical compounds used to kill or inhibit the growth of infectious organisms. An antibiotic was

originally defined in the 1940s as a substance produced by one microorganism which, in low concentrations, inhibited the growth of other microorganisms.

Antibiotics are naturally occurring substances produced by a fungus or bacteria. The use of the term has changed over the years, both because an increasing number of synthetic analogues or derivatives of “true” antibiotics have come on to the market.

Recently antibiotic refers to a substance produced by microorganisms or to a similar substance (produced wholly or partly by chemical synthesis, which in lower concentration inhibits the growth of another microorganism.

CLASSIFICATION OF ANTIBIOTICS

Antibiotics can be classified in various categories:

1. CLASSIFICATION ON BASIS OF SOURCE

A. NATURAL

- Natural source of antibiotics deals with antibiotic production from biological

components that include microorganism as prominent source.

- Natural source may include the antibiotic extraction from bacteria, fungi or actinomycetes.
 - *Bacillus polymyxa*– polymixin
 - *Penicillium notatum*– penicillin
 - *Cephalosporium acremonium*– cephalosporin
 - *Streptomyces venezuelae*– chloramphenicol

B. SEMI SYNTHETIC

- This includes use of microorganism to produce substances that is obtained from fermentation and then chemically modified with addition of functional group making a variation. For Example: Penicillin- ampicillin, amoxicillin, methicillin

C. SYNTHETIC

- The antibiotic falling under this category are obtained by chemical synthesis.
- Example: sulphonamides, quinolones

Classification on basis of spectrum of activity

A. BROAD SPECTRUM ANTIBIOTICS

- These are active against both Gram-positive and Gram-negative organisms.
- Examples include: tetracyclines, fluoroquinolones, “third-generation” and “fourth-generation” cephalosporins.

B. NARROW SPECTRUM ANTIBIOTICS

- They have limited activity and are primarily only useful against particular species of microorganisms either Gram positive or Gram negative.
- For example, glycopeptides and bacitracin are only effective against Gram-positive bacteria, whereas polymyxins are usually only effective against Gram negative bacteria.
- Aminoglycosides and sulfonamides are only effective against aerobic organisms, while nitroimidazoles are generally only effective for anaerobes.

3. CLASSIFICATION ON BASIS OF ACTIVITY AGAINST BACTERIA

- Bacteriostatic means those antibiotics that stops or inhibits the growth of bacteria that means no multiplication or generation of bacteria but they do not kill bacteria. Example: tetracycline, chloramphenicol
- Bactericidal means those antibiotics that actually kill bacteria by any mechanism depending on the antibiotic used. Example: aminoglycosides

4. CLASSIFICATION ON BASIS OF CHEMICAL COMPOSITION

1. β lactam antibiotics: penicillin, cephalosporin, carbapenem, monobactam
2. Tetracycline group of antibiotics
3. Aminoglycosides: streptomycin, neomycin, kanamycin, amikacin, gentamicin
4. Polypeptide: polymyxin, bacitracin

5. Glycopeptides: vancomycin, teicoplanin
6. Macrolide: erythromycin, clarithromycin, azithromycin
7. Rifamycin: rifampin, rifabutin
8. Streptogramins: pristinamycin, virginiamycin
9. Antifungal: griseofulvin, polyenes,
10. Synthetic drugs: quinolone, imidazole, nitrofurantoin derivatives
11. Miscellaneous: Chloramphenicol, Fusidic acid

CLASSIFICATION ON BASIS OF MODES OF ACTION:

1. Cell wall inhibitors: β lactam, bacitracin
2. Cell membrane inhibitors: polymyxin, azole antifungal agents
3. Protein synthesis inhibitors
 - 30S inhibitors: tetracycline, amikacin, gentamicin

- 50S inhibitors: erythromycin, chloramphenicol, clindamycin, lincomycin
 - tRNA inhibitors: Mupirocin, puromycin
4. Nucleic acid synthesis inhibitors: quinolone, rifampin, nitrofurantoin
5. Folate synthesis inhibitors: trimethoprim and sulphonamides

TYPES OF ANTIBIOTICS:

1. β lactam antibiotics

- For 20 years after their introduction, the penicillins were the only category of β – lactam antibiotics. In the mid-1960s, the penicillin antibiotics were joined by the cephalosporins, and towards the end of the 20th century by carbapenems and monobactams.
- These antibiotics have the same mechanism of antibacterial action and all possess the β – lactam ring as an integral part of their structure, but they differ widely in other characteristics.

- The mechanism of action of these antibiotics is cell wall inhibition.

2. TETRACYCLINES GROUP

- These are a class of antibiotics having nucleus of four cyclic rings and all are obtained from soil actinomycetes.
- The tetracyclines were first developed during the 1940s and 1950s and several that are still in use date from that time, e.g. tetracycline itself, oxytetracycline and chlortetracycline.
- Doxycycline and minocycline are more potent semisynthetic analogues discovered in 1966 and 1972 respectively, after which there were no significant developments until the introduction, in 2005, of tigecycline (a glycylglycine derivative), which is generally more potent again than other tetracyclines and maintains activity against some organisms that have become resistant to earlier members of the group.

- Although the tetracyclines can exhibit bactericidal activity by inhibiting ribosome function at concentrations that might be used in the laboratory, they are bacteristatic at concentrations that can safely be achieved in the body.
- They inhibit protein synthesis by binding to 30S ribosomes in susceptible organism.

3. AMINOGLYCOSIDE ANTIBIOTICS

- These are a group of natural and semi synthetic antibiotics having polybasic amino groups linked glycosidically to two or more aminosugar residues.
- Streptomycin was the first member discovered in 1944 by Waksman and his colleagues.
- Neomycin was the next to be isolated in 1949 and others members have been produced later.
- All the members of aminoglycosides are bactericidal and more active in alkaline pH.

- They act by interfering with the bacterial protein synthesis.
- All are active primarily against aerobic Gram negative bacilli, but spectrum differs.

4. MACROLIDES

- The macrolide antibiotics are large molecules comprising 12 – 16 – membered lactone rings linked through glycosidic bonds with amino sugars.
- Erythromycin was the first member of the group to be discovered in 1952 and it is still an important antibiotic today.
- They are commonly used for respiratory, skin and soft tissue infections.
- The macrolides all act by inhibiting protein synthesis in bacteria and they are regarded as bacteristatic drugs, although bactericidal activity may be achieved at high concentrations.

- The antimicrobial activity of erythromycin is pH – dependent, increasing with pH up to about 8.5, and the same effect occurs to varying degrees with other members of the group.

5. POLYPEPTIDE ANTIBIOTICS

- These are low molecular weight cationic polypeptide antibiotics.
- All are powerful bactericidal agents, but rarely used systemically due to toxicity.
- Bacitracin is one of the earliest discovered antibiotics from a strain of *Bacillus subtilis* and active against Gram positive organism.
- Bacitracin acts by inhibiting cell wall synthesis at a step earlier than that inhibited by penicillin.
- Polymixin B and Colistin which falls under this class are obtained in the late 1940s from *Bacillus polymyxa* and *Bacillus colistinus*

- Polymixin and Colistin are rapidly bactericidal agents; have a detergent like action on the cell membrane.

6. GLYCOPEPTIDE ANTIBIOTICS

- The only two important glycopeptide antibiotics currently available are Vancomycin and Teicoplanin.
- It has a complex tricyclic glycopeptide structure and its large molecular size means that it cannot penetrate through the outer membrane of most Gram – negative bacteria, so its use is effectively restricted to the treatment of infections by aerobic or anaerobic Gram – positive species.
- Vancomycin is bactericidal to most susceptible bacteria at concentrations near its minimum inhibitory concentration (MIC) and is an inhibitor of bacterial cell wall peptidoglycan synthesis, although at a site different from that of β – lactam antibiotics.

7. STREPTOGRAMINS

- Quinupristin/dalfopristin is a mixture of two streptogramins in a ratio of thirty to seventy, respectively.
- They are derived from a streptomycete and then chemically modified.
- They act by inhibiting protein synthesis.

8. MISCELLANEOUS ANTIBACTERIAL ANTIBIOTICS

A. CHLORAMPHENICOL

- Chloramphenicol was initially obtained from *Streptomyces venezuelae* in 1947 and later it was synthesized chemically.
- It is yellowish white crystalline solid, aqueous solution.
- It has a nitrobenzene substitution, which is probably responsible for its antibacterial activity.
- It acts by inhibiting protein synthesis.

B. FUSIDIC ACID

- Fusidic acid is a steroid – like, bactericidal antibiotic used primarily for its activity against staphylococci.
- It is active against penicillin – resistant strains of *aureus*, including MRSA, and may be administered in combination with erythromycin or clindamycin for severe staphylococcal infections.

C. CLINDAMYCIN

- Clindamycin is another antibiotic possessing significant bacteristatic activity towards Gram – positive cocci, although rather less activity is shown towards Gram – negative cocci and none at all against enterobacteria.
- Clindamycin is not related structurally to the macrolides but has a similar mechanism of action, so cross – resistance may occur between them.

D. LINCOMYCIN

- It is the forerunner of clindamycin and has similar antibacterial and toxic properties but is less potent.

9. SYNTHETIC ANTIMICROBIAL AGENTS

A. SULPHONAMIDES AND TRIMETHOPRIM

- Sulphonamides were discovered by Domagk in 1935.
- It had been shown that a red azo dye, prontosil, had a curative effect on mice infected with β – haemolytic streptococci; it was subsequently found that in vivo, prontosil was converted into sulphanilamide.
- The basis of the antimicrobial activity of the sulphonamides is their structural similarity to p – aminobenzoic acid (PABA) which is an integral part of the B vitamin, folic acid.
- In sensitive bacteria, sulphonamides compete with PABA with the result that folic acid synthesis is reduced.

- Chemical modifications of sulphanilamide gave compounds with higher antibacterial activity or special properties like prolonged activity.
- The sulfa drugs are seldom prescribed alone.
- Trimethoprim, a potent inhibitor of bacterial dihydrofolate reductase, exhibits an antibacterial spectrum similar to that of the sulfonamides.
- Trimethoprim is most often compounded with sulfamethoxazole, producing the combination called cotrimoxazole which was introduced in the mid-1970s.

B. QUINOLONES AND FLUOROQUINOLONES

- Quinolones are entirely synthetic antimicrobials active primarily against Gram negative bacteria, though fewer fluorinated compounds also inhibit some Gram positive ones.
- The first member Nalidixic acid was developed as a treatment for urinary tract infections in

1960s and had an antibacterial spectrum that was largely restricted to *coli* and other Enterobacteriaceae.

- The distinguishing feature of the first generation is the absence of a fluorine atom at position 6, so they are simply designated ‘quinolones’, whereas the second, third and fourth generations are termed fluoroquinolones.
- The first generation drugs are now little used, but those that followed in the 1980s, e.g. ciprofloxacin, norfloxacin, ofloxacin and levofloxacin (the L – isomer of ofloxacin) are widely used.
- Their greater activity is against *coli* and other Gram – negative urinary pathogens and involve wider antibacterial spectrum which includes Gram positive cocci and *Pseudomonas aeruginosa*.
- The third – generation quinolones, e.g. moxifloxacin, possess the attributes of their

predecessors but exhibit greater activity against *Streptococcus*

- The fourth generation, e.g. trovafloxacin , are also active against anaerobes.
- All the quinolones are bactericidal, and act by inhibiting the bacterial enzymes responsible for coiling of DNA.

C. NITROFURANTOIN

- Nitrofurantoin is the one remaining member of the nitrofuran group of drugs that is still in common use.
- Like metronidazole, nitrofurantoin requires its nitro group to be reduced in order to exhibit antimicrobial activity, and it too exhibits bactericidal activity by damaging DNA.

10. ANTIFUNGAL ANTIBIOTICS

- Fungal infections are normally less virulent in nature than are bacterial or viral ones but may, nevertheless, pose major treatment problems in individuals with a depressed

immune system, particularly in the case of systemic infection.

- The antifungal antibiotics includes azoles (imidazole and triazoles), polyenes, echinocandins, flucytosine.
- Each one has their own respective function or mode of action in treating fungal infection.

11. ANTITUBERCULAR DRUGS

- The antibiotics used for the treatment of tuberculosis belong to a variety of chemical classes, but it is convenient to consider them together in the same section for two reasons: first, most of them are used exclusively for tuberculosis, and second, therapy extends over several months, during which time resistance development is a significant possibility.
- The combination of isoniazid and rifampicin has been the mainstay of tuberculosis therapy from that time until the present day, although

other drugs like pyrazinamide and ethambutol have been added to the combination.

- The current approach is to treat tuberculosis in two phases: an initial phase of 2 months using isoniazid, rifampicin and pyrazinamide (with or without ethambutol), and a 4 month continuation phase with isoniazid and rifampicin.
- Second – line drugs available for infections caused by resistant organisms, or when first – line drugs cause unacceptable side effects, include amikacin, capreomycin, cycloserine, newer macrolides (e.g. azithromycin and clarithromycin) and moxifloxacin.

REFERENCES

1. Understanding Microbes in Sickness and in Health. National Institute of Allergy and Infectious Diseases.

<http://www.niaid.nih.gov/topics/microbes/documents/microbesbook.pdf>

2. Denyer, S.P., Hodges, N., Gorman, S.P. and Gilmore, B.F. (2011). Hugo and Russell's Pharmaceutical Microbiology. Eighth edition. A John Wiley & Sons, Ltd. Publication. Page no.169-193.
3. Clark, M.A., Finkel, R., Rey, J.A., and Whalen, K. (2012). Lippincott's Illustrated Reviews: Pharmacology. Fifth edition. Lippincott Williams & Wilkins, a Wolters Kluwer business. 351 West Camden Street Two Commerce Square Baltimore, MD 21201. Page no.381-440.
4. Tripathi, K.D. (1994). Essentials of Medical Pharmacology. Third edition. Jaypee Brothers Medical Publishers (P) Ltd. B-3 EMCA House 23/23B, Ansari Road, Daryaganj, New Delhi 110 002, India. Page no.614-716.