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# Navigation of medical microbiology to diagnostic microbiology

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**Abstract**
Diagnostic microbiology is a branch of medical science concerned with the prevention, diagnosis and treatment of infectious diseases. The kinds of microorganisms that cause infectious disease *i.e.* bacteria, fungi, parasites and viruses, and other type of infectious protein called proon. This study, studies the characteristics of pathogens, their modes of growth and transmission of infections. In this respect the entire field, as an applied science, can be conceptually subdivided into academic and clinical sub-specialties, although in reality there is a fluid continuum between public health microbiology and clinical microbiology or Diagnostic microbiology, just as the state of the art in clinical laboratories depends on continual improvements in academic medicine and research laboratories.

**Keywords:** Diagnostic microbiology, pathogens, proon, microbial culture

## Introduction
Diagnostic microbiology, the large subset of microbiology that is applied to medicine, is a branch of medical science concerned with the prevention, diagnosis and treatment of infectious diseases. In addition, this field of science studies various clinical applications of microbes for the improvement of health. There are four kinds of microorganisms that cause infectious disease: bacteria, fungi, parasites and viruses, and one type of infectious protein called proon.

Medical microbiology this studies the characteristics of pathogens, their modes of growth and transmission. The academic qualification of a Diagnostic/clinical/Medical Microbiologist in a hospital or medical research centre generally requires a Masters in Microbiology along with hair research institute "Doctor of Philosophy" in any of the life-sciences (Biochem, Micro, Biotech, Genetics, etc) [1]. Medical microbiologists often serve as consultants for physicians, surgeon, providing identification of pathogens and suggesting treatment options. Using this information, a treatment can be devised.

Other tasks may include the identification of potential health risks to the community or monitoring the evolution of potentially virulent or resistant strains of microbes, educating the community and assisting in the design of health practices. They may also assist in preventing or controlling epidemics and outbreaks of disease. Not all medical microbiologists study microbial pathology; some study common, non-pathogenic species to determine whether their properties can be used to develop antibiotics or other treatment methods.

## Material and method
Epidemicology, the study of the patterns, causes, and effects of health and disease conditions in populations, is an important part of medical microbiology, although the clinical aspect of the field primarily focuses on the presence and growth of microbial infections in individuals, their effects on the human body, and the methods of treating those infections. In this respect the entire field, as an applied science, can be conceptually subdivided into academic and clinical sub-specialties, although in reality there is a fluid continuum between public health microbiology and clinical microbiology or Diagnostic microbiology, just as the state of the art in clinical laboratories depends on continual improvements in academic medicine and research laboratories.

### Commonly treated infectious diseases

1. **Bacterial:** Streptococcal pharyngitis [2], chlamydia [3], typhoid fever [4], tuberculosis [5]
2. **Viral:** Rotavirus [6], hepatitis [7], human papillomavirus (HPV) [8]
3. **Parasitic:** Malaria [5], giardia lamblia [9], toxoplasma gondii [10]
4. **Fungal:** Candida [11], histoplasmosis [12], dandruff [13]

### Causes and transmission of infectious diseases

### Infection

Infections may be caused by bacteria, viruses, fungi and parasites. The pathogen that causes the disease may be exogenous (acquired from an external source; environmental, animal or other people, endogenous [14].

The site at which a microbe enters the body is referred to as the portal of entry [15]. Most important these include the respiratory tract disease, gastrointestinal tract disease, genitourinary tract disease, skin disease and mucous membranes disease [16]. The portal of entry for a specific microbe is normally dependent on how it travels from its natural habitat to the host.

There are various ways in which disease can be transmitted between individuals. These include [17].

- Direct contact - Touching an infected host, including sexual contact
- Indirect contact - Touching a contaminated surface
- Droplet contact - Coughing or sneezing
- Fecal – oral route - Ingesting contaminated food or water sources
- Airborne transmission - Pathogen carrying spores
- Vector transmission - An organism that does not cause disease itself but transmits infection by conveying pathogens from one host to another
- Fomite transmission - An inanimate object or substance capable of carrying infectious germs or parasites
- Environmental - Hospital-acquired infection (Nosocomial infections)

Like other pathogens, viruses use these methods of transmission to enter the body, but viruses differ in that they must also enter into the host's actual cells. Once the virus has gained access to the host's cells, the virus' genetic material (RNA or DNA) must be introduced to cell. Replication between viruses is greatly varied and depends on the type of genes involved in them. Most DNA viruses assemble in the nucleus while most RNA viruses develop solely in cytoplasm [18].

### Diagnostic tests

Most Important article: diagnostic microbiology Identification of an infectious agent for a minor illness can be as simple as clinical presentation; such as respiratory tract disease, gastrointestinal tract disease, genitourinary tract disease, skin disease and mucous membranes disease infections. In order to make an educated estimate as to which microbe could be causing the disease, epidemiological factors need to be considered; such as the patient's likelihood of exposure to the suspected organism and the presence and prevalence of a microbial strain in a community.

Diagnosis of infectious disease is nearly always initiated by consulting the patient's medical history and conducting a physical examination. More detailed identification techniques involve Microbiological culture, microscopy, biochemical tests and genotyping. Other less common techniques (such as X-Rays, CT scans, PET scan or NMR) are used to produce images of internal abnormalities resulting from the growth of an infectious agent.

### Microbiological culture

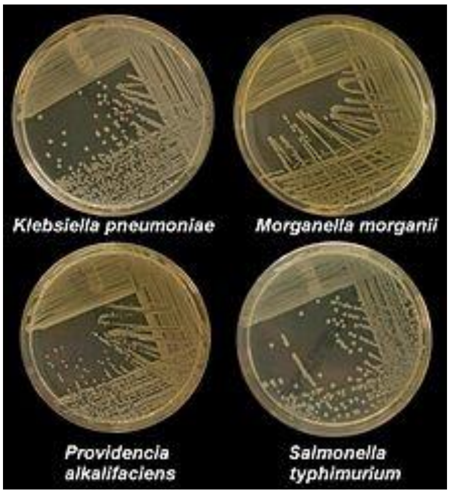


**Fig 1:** Four nutrient agar plates growing colonies of common Gram negative bacteria.

**Microbiological culture:** The primary method used for isolating infectious disease for study in the laboratory. Tissue or fluid samples are tested for the presence of a specific pathogen, which is determined by growth in a selective or differential medium.

### The 3 Most Important types of media used for testing are [21]

- Solid culture: A solid surface is created using a mixture of nutrients, salts and Agar. A single microbe on an agar plate can then grow into colonies containing thousands of cells. These are primarily used to culture bacteria and fungi.
- Liquid culture: Cells are grown inside a liquid media. Microbial growth is determined by the time taken for the liquid to form a colloidal suspension. This technique is used for diagnosing parasites and detecting mycobacteria [22].
- Cell culture: Human or animal cell culture are infected with the microbe of interest. These cultures are then observed to determine the effect the microbe has on the cells. This technique is used for identifying viruses.

### Microscopy

Culture Techniques will often use a microscopic examination to help in the identification of the microbe. Instruments such as compound light microscope can be used to assess critical aspects of the organism. This can be performed immediately after the sample is taken from the patient and is used in conjunction with biochemical staining techniques, allowing for resolution of cellular features. Electron microscopes are also used for observing microbes in greater detail for research [13].

### Biochemical tests

Fast and relatively simple biochemical tests can be used to identify infectious agents. For bacterial identification, the use of metabolic or enzymatic characteristics are common due to their ability to ferment carbohydrates in patterns characteristic of their genus and species. Acids, alcohols and gases are usually detected in these tests when bacteria are grown in selective liquid or solid media, as mentioned above. In order to perform these tests en masse, automated machines are used. These machines perform multiple biochemical tests simultaneously, using cards with several wells containing different dehydrated chemicals. The microbe of interest will react with each chemical in a specific way, aiding in its identification.

**Polymerase chain reaction**

Polymerase chain reaction assays are the most commonly used molecular technique to detect and study microbes [24]. As compared to other methods, sequencing and analysis is definitive, reliable, accurate, and fast [25]. Today, quantitative Polymerase chain reaction is the primary technique used, as this method provides faster data compared to a standard Polymerase chain reaction assay. For instance, traditional Polymerase chain reaction techniques require the use of gel electrophoresis to visualize amplified DNA molecules after the reaction has finished. Quantitative Polymerase chain reaction does not require this, as the detection system uses fluorescence and probes to detect the DNA molecules as they are being amplified [33]. In addition to this, Quantitative Polymerase chain reaction also removes the risk of contamination that can occur during standard Polymerase chain reaction procedures (carrying over Polymerase chain reaction product into subsequent Polymerase chain reactions) [24]. Another advantage of using Polymerase chain reaction to detect and study microbes is that the DNA sequences of newly discovered infectious microbes or strains can be compared to those already listed in databases, which in turn helps to increase understanding of which organism is causing the infectious disease and thus what possible methods of treatment could be used [25]. This technique is the current standard for detecting viral infections such as AIDS and hepatitis.

**Treatments**

Once an infection has been diagnosed and identified, suitable treatment options must be assessed by the physician and consulting medical microbiologists. Some infections can be dealt with by the body's own immune system, but more serious infections are treated with antimicrobial drugs. Bacteria infections are treated with antibacterials (often called antibiotics) whereas fungal and viral infections are treated with antifungals and antivirals respectively. A broad class of drugs known as antiparasitics are used to treat parasitic diseases.

Medical microbiologists often make treatment recommendations to the patient's physician, surgeon based on the strain of microbe and its antibiotic resistances, the site of infection, the potential toxicity of antimicrobial drugs and any drug allergies the patient has.

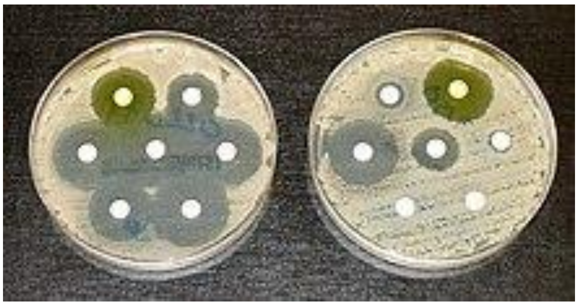

**Fig 2:** Antibiotic resistance tests

**Antibiotic resistance tests:** bacteria in the culture on the left are sensitive to the antibiotics contained in the white, paper discs. Bacteria in the culture on the right are resistant to most of the antibiotics.

In addition to drugs being specific to a certain kind of organism (bacteria, fungi, etc.), some drugs are specific to a certain genus or species of organism, and will not work on other organisms. Because of this specificity, diagnostic microbiologists must consider the effectiveness of certain antimicrobial drugs when making recommendations. Additionally, strains of an organism may be resistant to a certain drug or class of drug, even when it is typically effective against the species. These strains, termed resistant strains, present a serious public health concern of growing importance to the medical industry as the spread of antibiotic resistance worsens. Antimicrobial resistance is an increasingly problematic issue that leads to millions of deaths every year [27].

Whilst drug resistance typically involves microbes chemically inactivating an antimicrobial drug or a cell mechanically stopping the uptake of a drug, another form of drug resistance can arise from the formation of biofilms. Some bacteria are able to form biofilms by adhering to surfaces on implanted devices such as catheters and prostheses and creating an extracellular matrix for other cells to adhere to [28]. This provides them with a stable environment from which the bacteria can disperse and infect other parts of the host. Additionally, the extracellular matrix and dense outer layer of bacterial cells can protect the inner bacteria cells from antimicrobial drugs [29].

Diagnostic microbiology is not only about diagnosing and treating disease, it also involves the study of beneficial microbes. Microbes have been shown to be helpful in combating infectious disease and promoting health. Treatments can be developed from microbes, as demonstrated by Alexander Fleming's discovery of penicillin as well as the development of new antibiotics from the bacterial genus Streptomyces among many others [30]. Not only are microorganisms a source of antibiotics but some may also act as probiotics to provide health benefits to the host, such as providing better gastrointestinal health or inhibiting pathogens [31].

**Conclusion**

As microbiology is a subject of medical science but nowadays it has been converted into diagnostic microbiology. The diagnostic microbiology is not only about diagnosing and treating disease, it also involves the study of beneficial microbes. Microbes have been shown to be helpful in combating infectious disease and promoting health. Not only are microorganisms a source of antibiotics but some may also act as probiotics to provide health benefits to the host, such as providing better gastrointestinal health or inhibiting pathogens.

**Conflict of Interest**

Not available

**Financial Support**

Not available

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