Disease and Immunity

Matthew Williams • Biology • May 9, 2026

Disease and Immunity

Disease disrupts the normal functioning of the body. Understanding what causes disease, how it spreads, and how the body defends itself is central to public health — especially in the Caribbean, where tropical diseases such as malaria and dengue remain significant concerns.

Types of Disease

Not all diseases are caused by pathogens. The four main categories:

Type	Cause	Examples
Pathogenic	microorganisms (pathogens) invade the body	malaria, tuberculosis, gonorrhoea, COVID-19
Deficiency	lack of an essential nutrient	scurvy (vitamin C), rickets (vitamin D), anaemia (iron)
Hereditary	abnormal gene(s) inherited from parents	sickle cell anaemia, haemophilia, cystic fibrosis
Physiological	malfunction of body systems (not due to a pathogen or gene)	type 2 diabetes, hypertension, some cancers

> 📝 **Exam Tip**
> Sickle cell anaemia is hereditary, not pathogenic — it is caused by an abnormal allele, not a microorganism. An exam question may try to confuse these categories.

Pathogen Groups

Group	Characteristics	Examples	Diseases caused
Bacteria	prokaryotes; reproduce by binary fission; some produce toxins	Mycobacterium, Salmonella, Neisseria	tuberculosis, food poisoning, gonorrhoea

Viruses	non-cellular; require a host cell to replicate; very small	HIV, influenza virus, dengue virus	AIDS, influenza, dengue fever
Fungi	eukaryotes; reproduce by spores	Tinea, Candida	ringworm, athlete's foot, thrush
Protozoa	unicellular eukaryotes	Plasmodium, Giardia	malaria, giardiasis

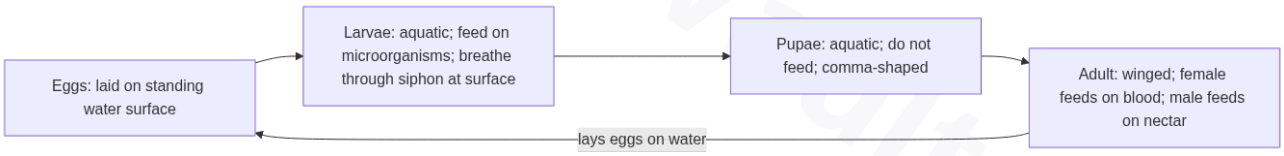
The Mosquito as a Disease Vector

A **vector** is an organism that transmits a pathogen from one host to another without being the primary host of the disease.

The **Anopheles mosquito** transmits malaria (caused by the protozoan Plasmodium). The **Aedes mosquito** transmits dengue, **yellow fever**, Zika, and chikungunya viruses.

Mosquito Life Cycle

The mosquito has a complete metamorphosis: egg ’larva ’pupa ’adult.



Mosquito life cycle

Only female mosquitoes bite — they need blood proteins for egg development. Male mosquitoes feed only on plant nectar.

Control at Each Stage

Life stage	Control methods
Eggs and larvae	remove or drain standing water; cover water containers; apply oil or larvicide to water surfaces; introduce mosquito fish (biological control)
Pupae	same as larvae — drain or treat water
Adults	insecticide spraying (indoors and outdoors); mosquito nets (bed nets); repellents; wearing long clothing; screens on windows and doors

Removing standing water is the most effective long-term strategy because it breaks the life cycle before mosquitoes become adults.

Transmission of Disease

Pathogens spread through several routes:

Route	Mechanism	Examples
Airborne	droplets or dust inhaled	tuberculosis, influenza, COVID-19
Waterborne	contaminated water ingested	cholera, typhoid
Foodborne	contaminated food consumed	salmonella, listeria
Direct contact	skin-to-skin or sexual contact	gonorrhoea, herpes, ringworm
Vectors	insects or animals carry pathogen to a new host	malaria (mosquito), dengue (mosquito)
Blood-borne	contaminated blood or needles	HIV, hepatitis B

The Body's Defences

Non-specific Defences

The first line of defence does not target any particular pathogen:

- **Skin** — physical barrier; slightly acidic surface discourages growth
- **Mucus** — traps pathogens in airways
- **Cilia** — sweep mucus and pathogens away from lungs
- **Stomach acid** — kills most ingested pathogens
- **Inflammation** — increased blood flow brings white blood cells to an infected area

Phagocytosis

Phagocytes (a type of white blood cell) engulf and destroy pathogens:

- 1. Phagocyte detects chemical signals from the pathogen
- 2. It surrounds the pathogen with pseudopodia (extensions of cytoplasm)
- 3. The pathogen is enclosed in a vacuole (phagosome)
- 4. Lysosomes fuse with the vacuole and release digestive enzymes
- 5. The pathogen is broken down

Antibodies and Lymphocytes

When a pathogen enters the body, its surface **antigens** are recognised as foreign. B-lymphocytes produce **antibodies** — proteins shaped to fit the antigen specifically:

- antibodies can neutralise toxins
- cause pathogens to clump (agglutination), making them easier to engulf
- mark pathogens for destruction by other white blood cells

B-lymphocytes also produce **memory cells** that persist long after the infection clears. On re-exposure to the same pathogen, memory cells respond rapidly — the **secondary immune response** — usually preventing illness.

Immunity

Type	Description	Duration
Natural active	body makes antibodies after infection; memory cells formed	long-lasting
Artificial active	body makes antibodies after vaccination; memory cells formed	long-lasting
Natural passive	antibodies passed from mother to baby (placenta; breast milk)	temporary (weeks to months)
Artificial passive	ready-made antibodies injected (antiserum)	temporary

Vaccination

A vaccine contains weakened or killed pathogens, inactivated toxins (toxoids), or pathogen proteins. The immune system responds as though facing real infection, producing antibodies and memory cells — without causing the disease.

If the vaccinated person later encounters the pathogen, the memory cells mount a rapid secondary response, clearing the pathogen before symptoms develop.

Herd immunity occurs when enough of a population is immune that a pathogen cannot spread efficiently, even protecting unvaccinated individuals.

Antibiotic Resistance

Antibiotics are medicines that kill bacteria or stop their growth. They do not work against viruses.

Antibiotic resistance develops through natural selection:

- 1. Within a bacterial population, occasional mutations produce bacteria resistant to an antibiotic
- 2. When the antibiotic is used, non-resistant bacteria die
- 3. Resistant bacteria survive and reproduce
- 4. Over time, the population becomes dominated by resistant strains

Overuse and misuse of antibiotics (not completing a course; using them for viral infections) accelerates resistance. Multi-drug-resistant bacteria ("superbugs") are a growing global health problem.

Social, Environmental, and Economic Impacts of Disease

Area	Impact
Social	school absenteeism; family stress; disability; stigma (especially for HIV/AIDS); reduced quality of life
Environmental	mosquito control programs use pesticides that can harm non-target organisms; drainage of wetlands for mosquito control destroys habitats
Economic	healthcare costs; lost productivity from illness; burden on health systems; reduced tourism (disease outbreaks); cost of disease control programs

Plant diseases also have economic impacts: fungal and bacterial diseases destroy crops, reduce yields, and threaten food security. Citrus canker, Panama disease (bananas), and coffee rust are regionally significant examples.

Managing Physiological Diseases: Hypertension and Diabetes

Physiological diseases are not caused by pathogens — they arise from malfunction of body systems. Diet and exercise play a central role in preventing and managing both hypertension and type 2 diabetes.

Hypertension (High Blood Pressure)

Hypertension puts strain on arteries and the heart, increasing the risk of stroke and heart attack.

Dietary management: reduce salt intake (lowers blood pressure); reduce saturated fat (lowers cholesterol and artery-narrowing); increase fruit, vegetables, and fibre.

Exercise: regular aerobic exercise strengthens the heart, lowers resting heart rate, and reduces arterial stiffness.

Type 2 Diabetes

In type 2 diabetes, cells become resistant to insulin, so blood glucose remains elevated after meals.

Dietary management: reduce simple sugars and refined carbohydrates (lowers glucose spikes); increase complex carbohydrates and fibre (slower glucose release); maintain a healthy body weight.

Exercise: increases muscle uptake of glucose (even without insulin); improves insulin sensitivity over time; helps control body weight.

> 📝 **Exam Tip**
> For both hypertension and diabetes, the exam expects you to name specific dietary changes (e.g. reduce salt, reduce sugar) and explain how they reduce the problem — not just say "eat healthy."

PRACTICE — DISEASE AND IMMUNITY

Pathogen
A microorganism that causes disease.

Vector
An organism that transmits a pathogen from one host to another (e.g. mosquito ’malaria).

Antigen
A foreign molecule on a pathogen's surface that triggers an immune response.

Antibody
A protein produced by B-lymphocytes that is specific to one antigen; helps destroy pathogens.

Phagocytosis
The process by which phagocytes engulf and digest pathogens.

Memory cells
Long-lived B-lymphocytes that allow a rapid secondary immune response on re-exposure to a pathogen.

Active immunity
Immunity involving the body making its own antibodies and memory cells; long-lasting.

Passive immunity
Immunity from receiving ready-made antibodies; short-lived; no memory cells produced.

Vaccination
Introduction of antigens to stimulate antibody and memory cell production without causing disease.

Herd immunity
When enough of a population is immune that a pathogen cannot spread efficiently.

Antibiotic resistance
The ability of bacteria to survive antibiotic treatment; develops through natural selection.

Anopheles mosquito
The vector for malaria; transmits Plasmodium when it takes a blood meal.