Human Health & Disease

Health (WHO) - complete physical, mental and social well-being, not merely absence of disease.

Determinants of Health

1. Genetic make-up
2. Lifestyle - diet, exercise, sleep
3. Environment - air, water, sanitation
4. Yoga + meditation - mental health
5. Vaccination + regular check-ups

Disease Categories

(a) Infectious - caused by pathogens (germ theory)
(b) Non-infectious - cancer, diabetes, heart disease
(c) Genetic - inherited disorders

Pathogen Types

Bacteria, virus, fungi, protozoa, helminths.
Each causes a distinct group of diseases.

Indian Health Initiatives

Mission Indradhanush, Ayushman Bharat,
Polio eradication (declared free 2014),
Pulse Polio, National Health Mission.
Smallpox eradicated globally - 1980 (WHO).

Bacterial Diseases

Disease	Pathogen	Symptoms
Typhoid	Salmonella typhi	High fever, headache, weakness
Pneumonia	Strep. pneumoniae	Alveolar fill, chest pain
Diphtheria	Corynebacterium	Throat membrane
Cholera	Vibrio cholerae	Severe diarrhoea
Tetanus	Clostridium tetani	Lock-jaw, muscle stiff
TB	Mycobacterium	Cough, blood, weight loss
Leprosy	M. leprae	Skin patches, nerve damage
Anthrax	Bacillus anthracis	Black skin lesions
Plague	Yersinia pestis	High fever, bubo

Typhoid (Mary case)

Confirmed by Widal test.

'Typhoid Mary' - asymptomatic ~~carrier~~ cook who spread it (1

Pneumonia

Alveoli filled with fluid -> breathing problems.

Spread - droplets, contact with infected.

Transmission Routes

Air, water, food, contact, sexual, vectors, blood.

Viral & Fungal Diseases

Viral

Disease	Virus
Common cold	Rhinoviruses
Influenza (flu)	Orthomyxovirus
Measles	Paramyxovirus
Mumps	Paramyxovirus
Polio	Enterovirus
Hepatitis-A/B	Hepatovirus
Rabies	Lyssavirus
Dengue	Flavivirus
AIDS	HIV (Retrovirus)

Common Cold

Caused by >200 rhinoviruses; nasal congestion, sore throat, cough, fatigue. Self-limiting.

Fungal Diseases

Ringworms (Microsporum, Trichophyton, Epidermophyton) - scaly, dry, itchy skin lesions; spread by sharing.

Candidiasis - Candida albicans (yeast).

Athlete's foot, dhobie's itch - common in warm, damp.

Protozoan & Helminth Diseases

Protozoan

Disease	Pathogen	Vector / Route
Malaria	Plasmodium	Female Anopheles
Amoebiasis	Entamoeba histolytica	Contaminated food
African sleeping sickness	Trypanosoma	Tsetse fly
Kala-azar (visceral)	Leishmania donovani	Sand fly
Giardiasis	Giardia lamblia	Water

Helminth (worm) Diseases

Ascariasis	Ascaris lumbricoides (roundworm)
Filariasis	Wuchereria bancrofti (filarial worm)
Taeniasis	Taenia solium / saginata (tape worm)
Schistosomiasis	Schistosoma (blood fluke)
Hook worm	Ancylostoma duodenale
Pinworm	Enterobius vermicularis

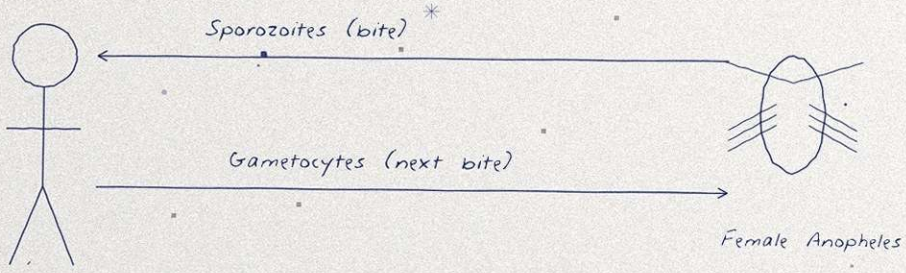
Filariasis

Adult worms live in lymph -> chronic inflammation.

Vector - Culex mosquito (microfilariae spread).

Causes ELEPHANTIASIS - gross swelling of limbs.

Malaria - Plasmodium Life Cycle



In HUMAN :

(i) liver cells (hepatocytes)
(ii) RBC -> burst -> haemozoin
(iii) gametocytes form

In MOSQUITO :

(iv) gametes fuse in gut
(v) oocyst on gut wall
(vi) sporozoites -> salivary gland

Species

P. vivax, P. malariae, P. ~~ovile~~ ovale, P. falciparum (deadliest).

Pathology

RBC rupture -> HAEMOZOIN released -> high fever + shaking chills every 3-4 days (depends on species).

Treatment

Chloroquine, quinine, artemisinin combination (ACT).

Immunity - Two Types

(A) Innate Immunity

Non-specific, present from BIRTH. Four barriers :

1. Physical - skin, mucous membranes
2. Physiological - saliva, gastric HCl, tears, sweat
3. Cellular - PMN-L, monocytes, NK cells
4. Cytokine - interferons (block viruses)

(B) Acquired (Adaptive) Immunity

Pathogen-SPECIFIC; develops with exposure; has MEMORY.

Two arms :

1. Humoral (AMI) - B-cells -> antibodies (in blood)
2. Cellular (CMI) - T-cells (in cells / tissues)

Primary vs Secondary Response

Primary - first exposure -> low intensity, slow

Secondary - re-exposure -> rapid + intense (MEMORY)

Active immunity - body makes own antibodies

Passive immunity - ~~self-made~~ ready-made antibodies given

Eg. mother's milk colostrum, anti-tetanus serum, anti-venom.

Vaccination Principle

Dead / attenuated pathogen -> memory cells -> immunity.

Antibody - Structure

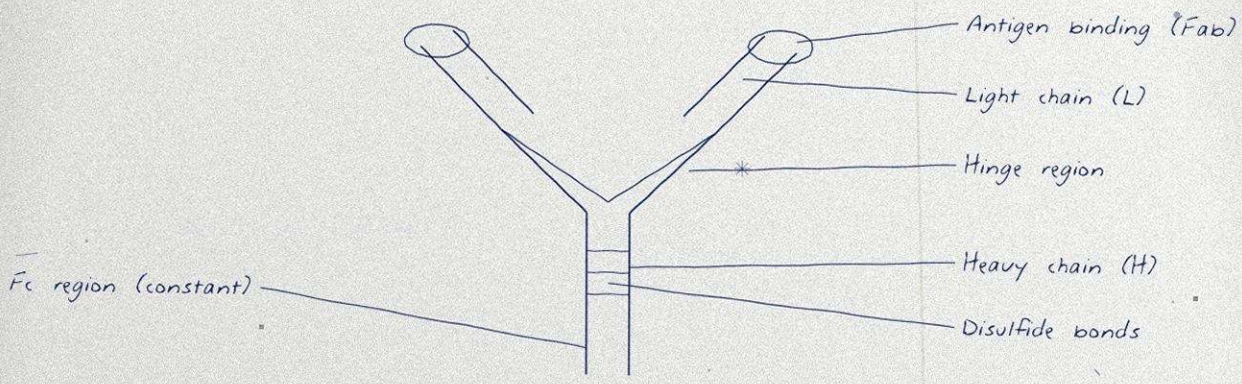


Fig. Y-shaped antibody - H_2L_2

Five Types - IgG, IgM, IgA, IgE, IgD

IgG	Most abundant, crosses placenta
IgM	Largest (pentamer), 1st to appear (primary)
IgA	Mucous + colostrum (dimer)
IgE	Allergy + parasites
IgD	B-cell surface receptor

How Antibodies Work

Bind antigen -> neutralise, opsonise, fix complement.

B & T Lymphocytes

B-cells

Mature in BONE MARROW.

Produce ANTIBODIES that fight pathogens in blood.

Drives HUMORAL (antibody-mediated) immunity.

T-cells

Mature in THYMUS gland.

Do NOT secrete antibodies; help in CELLULAR immunity.

Subtypes :

- Helper T (CD4) - activates B + T
- Cytotoxic T (CD8) - kills infected cells
- Memory T - long-term protection
- Suppressor T - regulates immune response

Allergy + Hypersensitivity

Exaggerated immune response to allergens (dust, pollen)

Mediated by IgE + histamines released from mast cells.

Symptoms : sneezing, watery eyes, runny nose, rash.

Treatment - anti-histamine drugs, steroids.

Auto-Immune Diseases

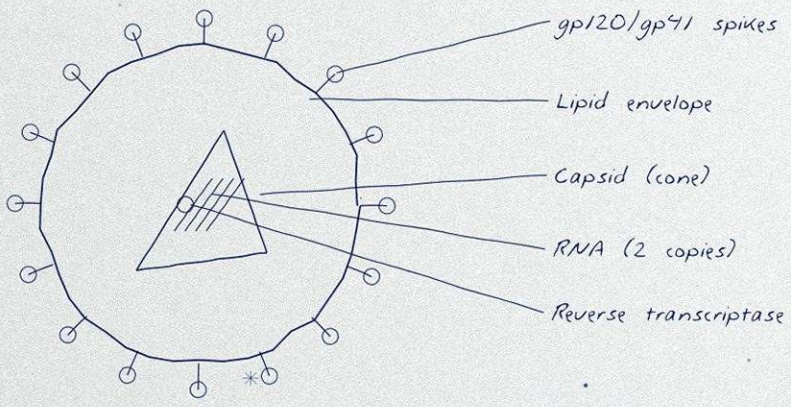
Body attacks self-cells. Eg. rheumatoid arthritis,

SLE (lupus), type-1 diabetes, ~~polio~~ myasthenia gravis.

Organ Transplant

HIV & AIDS

AIDS = Acquired Immuno Deficiency Syndrome.
Causative agent - Human Immuno-deficiency Virus (HIV) - a retrovirus.
Discovered 1981; 38 million HIV+ globally today.



Transmission

1. Sexual contact with infected person
2. Sharing infected needles
3. Blood transfusion (rare since 1990s)
4. Mother to foetus / breast milk

NOT Spread By

HIV - Pathology

Course of Infection

1. HIV enters via mucosa (sex / needle / blood)
2. Attaches to macrophages via gp120 + CD4
3. RNA -> DNA (reverse transcriptase)
4. DNA integrates into host = provirus
5. Provirus produces new viruses from infected T-helper
6. T-helpers die - immunity collapses
7. Opportunistic infections take over = AIDS

Diagnosis

ELISA - detects anti-HIV antibodies (initial screen)

Western blot - confirmatory test

PCR - detects HIV RNA directly (early or babies)

Treatment

ART - Anti-Retroviral Therapy (drug cocktail)

AZT (zidovudine), 3TC, NVP - reverse trans. inhibitors

Protease inhibitors + integrase inhibitors -> ~~cure~~ viral suppress

Prevention

(i) Awareness through education

(ii) Safe sex (condoms)

(iii) Screening of blood + organ donors

(iv) Disposable needles only ; mother PMTCT.

Cancer - Basics

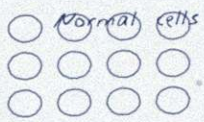
Cancer = uncontrolled proliferation of cells with LOSS of contact inhibition.
2nd leading cause of death globally.

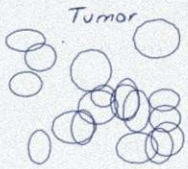
Types

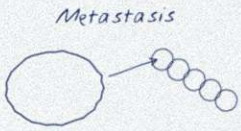
1. Carcinoma (epithelial - skin, breast, lung)
2. Sarcoma (connective - bone, muscle)
3. Leukemia (blood)
4. Lymphoma (lymph)

Tumor Types

Benign - localised, doesn't spread, less harmful
Malignant - invasive, METASTATIC, life-threatening







Causes - Carcinogens

PHYSICAL - UV, X-ray, gamma rays
CHEMICAL - tobacco, asbestos, aflatoxins, benzene
BIOLOGICAL - HPV, EBV, HBV, oncogenes (cellular)
LIFESTYLE - alcohol, diet, obesity, stress.

Cancer - Detection & Treatment

Detection Methods

(a) Biopsy - remove + microscopy of tissue
(b) Blood tests - WBC count (leukemia), tumor markers
(c) X-ray, CT scan, MRI, USG
(d) Mammography - breast
(e) PAP smear - cervical
(f) Endoscopy - GI tract
(g) MoAb (monoclonal antibodies) - specific markers

Oncogenes

Mutated proto-oncogenes -> cancer.
Many viral oncogenes too (HPV E6/E7, EBV LMP).

Treatment - Triad

1. Surgery (remove tumor)
2. Radiotherapy (X-ray, gamma-ray)
3. Chemotherapy (drugs - vincristine, taxol)

Immunotherapy

alpha-interferon - activates immune system
MoAb-based targeted therapy
CAR-T cells (new) - engineered T-cells

Prevention

Drug & Alcohol Abuse

Drug abuse = use of drugs for non-medical reasons, in amounts harmful to user and others.

Common Drugs of Abuse

Opioids	Heroin, smack, morphine	Depressant - papaver
Cannabinoids	Marijuana, ganja, hashish, charas	From Cannabis sativa
Cocaine	Coca, crack	Stimulant - Erythroxylum
Stimulants	Amphetamines, caffeine, nicotine	
Hallucinogens	LSD, psilocybin	
Tobacco	Cigarettes, beedis, gutkha	Nicotine alkaloid
Alcohol	Beer, wine, spirits	Ethanol depressant

Effects of Abuse

Short-term : reckless behaviour, accidents, vandalism

Long-term : organ damage (liver, lung), HIV/Hep-B, dependence, mental disorders, death.

Reasons for Initial Use

Curiosity, peer pressure, frustration, depression, family history, glamorisation in media.

Doping

Prevention - Drug Abuse

Warning Signs

(a) Drop in academic performance
(b) Withdrawal from family / friends
(c) Aggressive / rebellious behaviour
(d) Loss of interest in hobbies
(e) Change in sleep + eating habits
(f) Bloodshot eyes, weight loss
(g) Stealing money, lying about whereabouts

Prevention + Control

1. Avoid undue peer pressure
2. Education + counselling
3. Seeking help from parents + peers
4. Looking for danger signs
5. Seeking professional + medical help

Govt + NGO Programmes

Narcotic Drugs + Psychotropic Substances Act, 1985
National Drug De-Addiction Programme
Re-habilitation centres + support groups (AA).

Withdrawal Symptoms

Anxiety, sweating, shakiness, cravings, nausea, seizures (severe), ~~relief~~ sometimes death (alcohol DT).

Smoking + Tobacco

Tobacco - leaves of Nicotiana tabacum.
Active alkaloid = NICOTINE.
Stimulates adrenal -> adrenaline + noradrenaline release.

Health Effects

1. Cancer - lung, oral, urinary, throat
2. Bronchitis + Emphysema
3. Heart disease, hypertension
4. Gastric ulcers
5. Reduced fertility

Passive Smoking

Inhaling smoke from others - same risks for non-smokers around heavy smokers.
Pregnant women smoking -> low birth weight, preterm delivery, SIDS.

Quitting Methods

Behavioural therapy, nicotine patches/gum, varenicline, bupropion, support groups.

Alcohol

Liver - cirrhosis ; brain - dementia, pancreatitis, gastritis, heart - cardiomyopathy.

Vaccines & Immunisation

Types of Vaccines

Type	Example
Live attenuated	BCG (TB), Polio (oral), MMR
Killed / Inactivated	Salk polio, rabies, cholera
Toxoid	Diphtheria, tetanus
Sub-unit / Recombinant	Hep-B (HBsAg in yeast)
mRNA (new)	COVID-19 (Pfizer, Moderna)
Viral vector	COVID-19 (Covishield, Sputnik V)

Indian Immunisation Schedule

BCG, OPV - at birth

DPT (Diphtheria-Pertussis-Tetanus), Polio, Hep-B - 6, 10, 14

Measles - 9 months

MMR (Mumps + Rubella) + Boosters

Tetanus boosters every 5-10 years

Successes of Vaccination

Smallpox - eradicated globally 1980 (WHO).

Polio - India declared polio-free in 2014.

COVID-19 - record-time vaccines (mRNA - ~~years~~ months).

MoAb Production

Non-Infectious Diseases - Brief

Diabetes Mellitus

Type-1 - insulin deficiency (auto-immune)

Type-2 - insulin resistance (lifestyle linked)

Symptoms : polyuria, polydipsia, polyphagia, weight loss

Tx : diet, exercise, insulin / oral hypoglycemics.

Cardiovascular Diseases

Hypertension - >140/90 mmHg

Atherosclerosis - cholesterol plaques in arteries

Coronary artery disease, heart attack, stroke.

Risk factors : smoking, obesity, sedentary, fat-rich diet.

Asthma

Bronchial inflammation -> wheezing, breathlessness.

Triggers : pollen, dust, smoke, cold air, stress.

Tx : bronchodilators (salbutamol), corticosteroids.

Obesity

BMI > 30 kg/m 2. Causes diabetes, heart disease, cancer (some), joint problems.

Mental Health

Depression, anxiety, schizophrenia.

Yoga + meditation + therapy + medication.

MoAb & Hybridoma Technology

Antibodies against a SINGLE specific antigen, all identical, produced by a single B-cell clone. Discovered by Kohler + Milstein (1975, Nobel 1984).

Procedure

1. Inject antigen into mouse
2. Isolate B-cells from mouse spleen
3. Fuse with myeloma cells -> HYBRIDOMA
4. Hybridomas immortalised, produce 1 antibody
5. Select + clone the best one
6. Mass produce in culture / bioreactor

Applications

(a) Cancer diagnosis + therapy (Herceptin)
(b) HIV + Hep-B detection (ELISA)
(c) Pregnancy test (hCG MoAb)
(d) Anti-venom + anti-toxin
(e) Targeted drug delivery
(f) COVID-19 MoAb therapy

Cytokines

Small proteins that mediate immune response.
Eg. Interferons (antiviral), interleukins, tumor necrosis factor (TNF).

Disease Glossary

Pathogen	- disease-causing organism
Endemic	- always present in a region
Epidemic	- sudden spread in a population
Pandemic	- global spread (COVID)
Carrier	- asymptomatic infected (Typhoid Mary)
Vector	- transmits pathogen (mosquito)
Reservoir	- long-term host (bats for some virus)
Symptom	- felt by patient (pain, fever)
Sign	- observed by doctor (rash, rate)
Vaccine	- biological preparation -> immunity
Antibiotic	- kills bacteria (not viruses)
Antiviral	- blocks viral replication
Antibody	- immunoglobulin protein
Antigen	- anything provoking immune response
MHC	- self vs non-self markers
Allergy	- exaggerated response to allergen
Cytokine	- immune signaling protein
Toxoid	- inactivated toxin vaccine
Tumor	- abnormal growth
Metastasis	- spread of cancer

Recap & Key Facts

Vectors

Anopheles - Malaria

Aedes - Dengue, Yellow fever, Chikungunya, Zika

Culex - Filariasis (Wuchereria)

Tsetse fly - Sleeping sickness

Sand fly - Kala-azar

Rat flea - Plague

Pathogen Quick List

Tuberculosis	*Mycobacterium tuberculosis*
Leprosy	*M. leprae*
Typhoid	*Salmonella typhi*
Cholera	*Vibrio cholerae*
Malaria	*Plasmodium*
Amoebiasis	*Entamoeba*
Filaria	*Wuchereria*
Ringworm	*Microsporum, Trichophyton*
AIDS	HIV
Cancer	Cellular oncogenes / viruses

Indian Achievements

Smallpox eradicated 1980 ; Polio-free 2014

India produces 60% of world's vaccines.

Covaxin (Bharat Biotech) - 1st indigenous mRNA vaccine.