Unit 28 · Microbial Diseases

STUDY NOTES

WHAT NEB'S GRADE 12 EXAM ASKS

- **CDC's grid (2078):** Applied Biology (Units 27–29 together): 9 of 75 marks; 1 MCQ (knowledge) and 1 long question (8 marks: knowledge 1, understanding 3, application 2, higher ability 2)
- **The paper:** Botany 37 + Zoology 38; each part: MCQs × 1 (5 Botany, 6 Zoology) · 4 short × 4 · 2 long × 8; one OR in each short and long group; 3 hours; 1 mark per expected point
- **Our model papers:** Paper 1: MCQ (BCG at birth); long question on cholera in four parts (the organism; how the toxin causes diarrhea; ORS for 2 liters; why ORS works)
- **MCQ (1 mark), from the exercise**
  - RG-1 causes no disease; Ebola RG-4; BSL-2 for RG-2
  - RG-3 = HG-3
  - communicable: ascariasis, typhoid, TB
  - bacterial: TB, typhoid, cholera
  - most severe hepatitis: D
  - HIV weakens immunity
  - *Salmonella* Typhi; *M. tuberculosis*; TB air-borne
  - fluconazole for candidiasis
  - hepatitis B vaccine: 2nd generation
- **Short and long (in parts)**
  - risk groups, hazard groups, biosafety levels
  - epidemiology of influenza
  - notes on hepatitis B, candidiasis
  - immunity and its types
  - vaccines, vaccination and their types
  - HIV/AIDS: agent, drug users, organs, spread, symptoms, prevention
  - typhoid; TB and DOTS
  - cholera: why microbial, physical, acquired, communicable, pandemic, water-borne

Key terms

Health (WHO): "complete physical, mental and social well-being and not merely the absence of disease or infirmity".

Disease: any change from health (body, mind, life with others) causing discomfort, disability or harm; **microbial disease**: caused by microorganisms.

Pathogen: a microbe that causes disease (virus, bacterium, fungus, protozoan, some worms).

Hazard: anything that **could** cause harm; **risk**: the **chance** that it does.

Infection: a pathogen entering the body and multiplying there.

Carrier: carries and spreads a pathogen without being ill; **human-carrier** (anthroponotic) disease: people the only reservoir (typhoid, cholera).

Opportunistic infection: one a healthy immune system keeps away (TB, candidiasis in AIDS).

Immunity: the body's ability to resist foreign substances (pathogens, toxins).

Antigen: a foreign substance that sets off acquired immunity; **antibody** (immunoglobulin): Y-shaped protein against one antigen.

Vaccine: killed, inactivated or attenuated microbes, their parts, toxoids or their genes, giving immunity without the disease; **vaccination** (immunization, inoculation): giving it → **active** immunity.

Herd immunity: enough people immune that each case causes < 1 new case.

1. Risk and hazard groups

Risk groups (WHO), by: disease in people? how serious? how easily spread? vaccines and treatment?

Group	What	Examples
RG-1	unlikely to cause disease; no or low risk	*E. coli* K-12, *Lactobacillus acidophilus*, *Bacillus subtilis*, *Aspergillus niger*, *Saccharomyces cerevisiae*
RG-2	can cause disease, not usually serious; treatment and prevention available; limited spread	influenza, rotavirus, herpes simplex; *Streptococcus pneumoniae*; *Aspergillus flavus*, *Candida albicans*; *Plasmodium vivax*, *Leishmania donovani*; eggs and larvae of flukes, tapeworms, filarial and eye worms
RG-3	usually serious; treatment and prevention available; no casual spread	HBV, HCV, HIV, SARS coronavirus; *M. tuberculosis*, *Salmonella* Typhi, *Yersinia pestis*; *Blastomyces dermatitidis*
RG-4	serious, often deadly; spreads readily; usually no treatment or prevention	Ebola, Marburg, Lassa viruses

Hazard groups (UK): human pathogens, by infection? severity? community spread? **prophylaxis** or treatment?

- **HG-1**: unlikely to cause disease
- **HG-2**: can cause disease, a hazard to workers; spread **unlikely**; treatment usually available
- **HG-3**: **severe** disease, serious hazard; **may** spread; treatment usually available
- **HG-4**: severe, serious hazard; **likely** to spread; usually **no** treatment

Biosafety levels (the lab), set by infectivity, severity, transmissibility, kind of work; BSL-n for RG-n or HG-n:

- **BSL-1**: open bench, handwashing, no eating
- **BSL-2**: coats, gloves, **biosafety cabinet**, autoclave, limited entry (most hospital labs in Nepal)
- **BSL-3**: sealed, two doors, air drawn in and filtered, respirators
- **BSL-4**: separate building, own air and waste; **pressurized suits** or glove boxes

Six kinds of hazard

1. **biological**: microbes, blood, body fluids, harmful plants, sewage, dust, vermin
2. **chemical**: acids, pesticides, solvents, gases
3. **physical**: altitude, noise, radiation, pressure, heat, cold
4. **safety**: broken furniture, exposed wires, wet floors
5. **ergonomic**: poor office setup, posture, heavy loads
6. **psychosocial**: stress, harassment, bullying, violence

- biological agents: toxins, allergens, cancer-causing agents, microbes; pathogens → **pathogenic diseases**
- worms (helminths) studied with microbes: their **eggs and larvae are microscopic**

2. How diseases spread

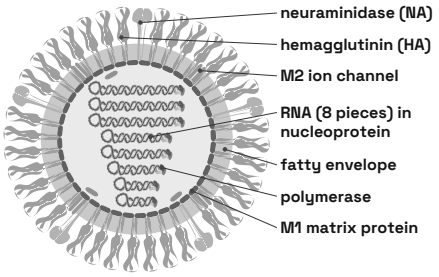
- chain: **reservoir** → way out → **mode of transmission (MoT)** → way in → **susceptible** host; break any link
- **Direct**: contact; **droplets** (cough, sneeze; fall within 1–2 m); mother to baby (placenta, birth, milk)
- **Indirect**: **vehicles** (food, water, blood, needles, towels); **vectors** (mosquitoes, flies, ticks); **air** (droplet nuclei float for hours: TB)

Labels for a disease

- **physical** / mental; **congenital** (at birth) / **acquired**
- **communicable** (infectious; contagious by contact) / non-communicable
- **endemic**: always present at a steady level (typhoid in Nepal)
- **epidemic**: many more cases than usual at one time
- **pandemic**: an epidemic across continents (COVID-19; cholera, 7 since 1817)
- **sporadic**: scattered cases
- **enzootic** / **epizootic**: always in animals / outbreak in animals; **zoonotic**: caught from animals (rabies, bird flu)
- by route: **air-borne**, **water-borne**, **food-borne**, **vector-borne**, **blood-borne**

I. Influenza

- acute viral infection of the airways; sudden **fever, chills, aching muscles, great tiredness**; Nepal: winter, second rise in monsoon
- physical, acquired, communicable, **air-borne**; endemic with yearly epidemics; pandemic with a new virus; A enzootic in birds, pigs, some strains zoonotic
- pandemics: first record **1510**; **1918** Spanish flu (~50 million dead); 1957, 1968, 2009; seasonal ~1 billion cases, 290,000–650,000 deaths a year
- high risk: under 5, over 65, pregnant, weak immunity, heart, lung, kidney, liver disease, diabetes, obesity
- **agent**: RNA viruses, **Orthomyxoviridae**; spikes **hemagglutinin (H)** (enters cells) and **neuraminidase (N)** (frees new viruses); **8 RNA pieces**
  - **A**: people, birds, pigs (H1N1, H3N2); only A pandemic
  - **B**: people only; **C**: mild colds; **D**: cattle
- spread: **droplets** to ~2 m; hands, surfaces; incubation **1–4 days** (about 2)
- complications: pneumonia, bronchitis, asthma, heart, ear and sinus infections, **ARDS**
- diagnosis: symptoms; swab by **RT-PCR**, culture, immunofluorescence, rapid antigen tests
- prevention: hand washing, covering coughs, masks, staying home, yearly **vaccine** (spikes change: **antigenic drift**, **shift**)
- treatment: rest, fluids, paracetamol; antivirals within 2 days: **oseltamivir** (Tamiflu), zanamivir, peramivir, baloxavir; not antibiotics



An influenza A virus cut open.

II. Hepatitis

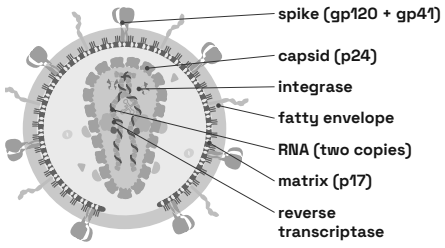
- **inflammation of the liver** (its parenchyma); mostly by 5 viruses, A–E
- acute: fever, tiredness, nausea, pain under right ribs, **dark urine**, **jaundice** (bilirubin not cleared)
- A and E **cleared**; B, C, D can be **chronic** → **cirrhosis**, **liver cancer**
- 2022: 254 million with B, 50 million with C; 1.3 million deaths; **28 July** World Hepatitis Day (Blumberg)

	A	B	C	D	E
other names	infectious hepatitis, epidemic jaundice	serum hepatitis	"non-A, non-B"; silent killer	delta agent	enteric, water-borne
virus	RNA, no envelope	**DNA**; Dane particle; HBsAg, HBcAg, HBeAg	RNA, enveloped	RNA, **incomplete**: uses HBsAg	RNA
spread	**feco-oral**	**blood**, sex, mother to baby	**blood**; rarely sex, birth	blood, sex; **only with HBV**	**feco-oral**, water; undercooked meat
incubation	15–50 days (2–4 weeks)	30–180 days (~75)	2 weeks–6 months (6–9 weeks)	1–6 months	2–10 weeks (5–6)
chronic?	never	90% of newborns, < 5% of adults	~70%	often; most severe	no (only weak immunity)
diagnosis	anti-HAV IgM; RT-PCR	**HBsAg**	anti-HCV, then RT-PCR	anti-HDV, RT-PCR	anti-HEV IgM, RT-PCR
prevention	clean water, vaccine	**vaccine** (pentavalent 6, 10, 14 weeks), screened blood	no vaccine; sterile needles	HBV vaccine	safe water; vaccine in China
treatment	rest	tenofovir, entecavir	direct-acting antivirals cure > 95%	interferon, bulevirtide	rest; hospital in pregnancy

- B: **50–100 × more infectious than HIV**; 1986 vaccine: first **genetically engineered**
- C: signs late: bruising, ascites, itchy skin
- D: co-infection or **superinfection** (worse); fastest to cirrhosis
- E: up to **1 in 5** deaths in late pregnancy; Kathmandu Valley epidemics

III. HIV/AIDS

- **AIDS**: acquired immunodeficiency syndrome, the late stage of **HIV** (human immunodeficiency virus) infection; destroys **helper T (CD4) cells**
- acquired (and mother to baby); communicable, **blood-borne**, **sexually transmitted**; **pandemic**; physical; **1 December** World AIDS Day
- 1981 described (USA); 1983 **LAV** (Barré-Sinoussi, Montagnier); 1984 **HTLV-III** (Gallo); 1986 named HIV
- 2025: ~41 million with HIV; Nepal first case **1988**; **concentrated** epidemic (drug injectors, sex workers, migrants); ~34,000 (2024)
- **agent**: **retrovirus** (*Lentivirus*); 2 single-stranded **RNA**; **reverse transcriptase** (RNA → DNA); spikes **gp120**, **gp41**; **HIV-1** worldwide, **HIV-2** West Africa
- carried by blood, semen, vaginal fluids, breast milk; **not** sweat, tears, saliva, urine, hugging, food, mosquitoes



HIV, cut open: spike (gp120 + gp41), capsid, RNA, reverse transcriptase, integrase, matrix, envelope.

Life cycle in a helper T cell

1. **attachment**: gp120 → **CD4** + **CCR5** or **CXCR4**
2. **fusion**: gp41; capsid enters
3. **reverse transcription**: RNA → DNA
4. **integration**: **integrase** puts DNA in the chromosome (**provirus**)
5. viral RNA and proteins made
6. **budding**; **protease** cuts proteins; T cell dies

Mode of transmission (direct)

- **sexual**: commonest; ~0.08% per act (woman), anal ~1.4%
- **blood**: transfusion > 90%; shared needle ~0.6% a time, repeated
- **mother to baby** (vertical): 15–45% untreated, < 2% treated
- incubation: first illness 2–6 weeks; AIDS after ~**10 years** untreated

Stages

1. **acute**: flu-like (fever, rash, sore throat); **window period** 2 weeks–3 months (antibody test negative, infectious)
2. **clinical latency**: years, no symptoms; **generalized lymphadenopathy**
3. **symptomatic** (ARC): fever, diarrhea > 1 month; > 10% weight lost ("slim disease")
4. **AIDS**: CD4 < 200 per μL (healthy 500–1,500); **opportunistic infections**: TB (leading killer), *Pneumocystis* pneumonia, candidiasis, *M. avium*, Kaposi's sarcoma

- **effects**: no helper T cells → fewer antibodies, no killer T cells → whole immune system weakened
- **parts affected**: helper T cells, macrophages, dendritic cells in blood, **lymph nodes**, gut lining; in AIDS the **lungs** (TB, pneumonia), mouth and esophagus (candidiasis), gut, brain, skin
- **diagnosis**: **ELISA**, rapid tests (Nepal: three in turn); **Western blot** (old confirmatory); viral load (RT-PCR), CD4 count
- **prevention**: faithful partner, condoms; screened blood; sterile needles; testing and treating pregnant women; **U = U**; **PrEP**, **PEP** (within 72 h)
- **treatment**: no cure; **ART** (HAART), drugs together: **zidovudine** (AZT, 1987), nevirapine (reverse transcriptase), saquinavir (protease), **dolutegravir** (integrase); free in Nepal

IV. Typhoid

- **typhoid fever** (म्यादी ज्वरो), **enteric fever**; gut → lymph tissue, liver, spleen → blood
- acquired, communicable, **water-borne**, **food-borne**, **human-carrier**; **endemic** in Nepal
- ~9 million cases, 110,000 deaths a year (2019); antibiotic resistance
- **agent**: *Salmonella enterica* serovar **Typhi**; **Gram-negative**, flagellated rod; humans only; Paratyphi A, B, C → paratyphoid
- spread: **feco-oral** (urino-oral); healthy **carriers** (bacteria in the gallbladder; 2–5% of those who recover); flies
- incubation **6–30 days** (1–2 weeks)
- symptoms: **step-ladder fever**, headache, stomach pain, constipation or diarrhea, **relative bradycardia**, **rose spots** (2nd week)
- effects (3rd week): **Peyer's patches** ulcerate → intestinal **bleeding**, **perforation**; sepsis, liver, rarely meningitis

Diagnosis by week

1. **blood culture** (most reliable)
2. **Widal test** (unreliable alone in Nepal)
3. **stool culture**
4. **urine culture**

- when others fail: **bone marrow culture** (most sensitive)
- prevention: safe water, toilets, hand washing, food hot, fruit peeled; **TCV** (one injection; Nepal 2022, at **15 months**)
- treatment by sensitivity: **azithromycin**, **ceftriaxone**; ciprofloxacin fails in South Asia; chloramphenicol (1948) little used

V. Tuberculosis

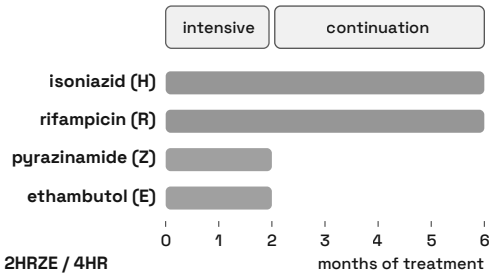
- **TB**, **Koch's disease**; mostly **lungs**; राजरोग → क्षयरोग
- acquired (shared air, not genes; congenital TB very rare); communicable, **air-borne**; was pandemic ("white plague"); endemic in Nepal; **24 March** World TB Day (Koch, 1882)
- deadliest infection: 2024, 10.7 million ill, 1.23 million dead; ¼ of people **latent** (5–10% fall ill); Nepal ~67,000 ill, 16,000 dead (2024)
- risk: overcrowding, poor ventilation, poverty, **undernourishment**, carpet and garment factories, **HIV**, diabetes, smoking, alcohol

Types

- **pulmonary**: lungs and pleura; commonest; spreads
- **extrapulmonary**: abdominal; spine (**Pott's spine**); skin (**lupus vulgaris**); lymph nodes; **TB meningitis**; kidneys
- **miliary**: through blood to many organs; millet-seed lesions
- **agent**: *Mycobacterium tuberculosis*: slender, non-motile, no spores, **obligate aerobe** (upper lobes), slow (15–20 h); waxy **mycolic acid** wall → **acid-fast** (**Ziehl–Neelsen**); *M. bovis* in cattle (raw milk; BCG strain); *M. avium* in AIDS; *M. leprae* leprosy
- spread: **droplet nuclei** for hours; raw milk; incubation **3 weeks–3 months**
- symptoms: **cough > 2 weeks**, **hemoptysis**, evening fever, **night sweats**, **anorexia**, chest pain, weight loss
- effects: lung **cavities**; other organs as above
- diagnosis: sputum microscopy (2 samples, one early morning), **GeneXpert** (DNA in 2 h, rifampicin resistance), culture; **Mantoux** (swelling after 2–3 days); chest X-ray
- prevention: early treatment, ventilation, covering coughs, masks; **BCG at birth** (intradermal; protects against miliary TB and TB meningitis); boiled milk

Treatment (ATT)

- **isoniazid (H)**, **rifampicin (R)**, **pyrazinamide (Z)**, **ethambutol (E)**; **streptomycin (S)** (1943, injected)
- ethambutol **bacteriostatic**; others **bactericidal**
- rifampicin: orange-red urine, sweat, tears (harmless)
- isoniazid uses up **vitamin B_6** → **peripheral neuritis**, so B_6 given
- **2HRZE/4HR**: 2 months of four drugs (intensive), 4 months of two (continuation)
- **MDR-TB** = multidrug-**resistant** (H and R)
- **DOTS** (directly observed treatment, short-course): a health worker **watches every dose**, free, sputum checked, cases recorded; stops patients quitting and breeding resistance; Nepal **April 1996**, all districts **2001**; center at Thimi, Bhaktapur

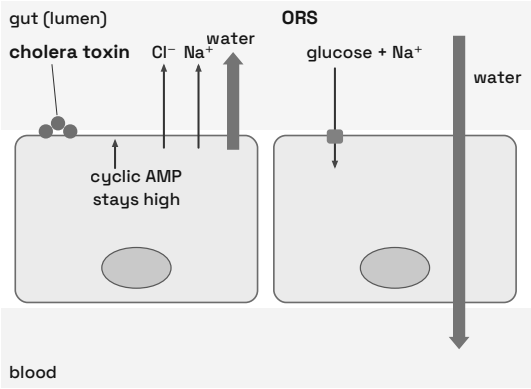


The six-month course for a new patient.

VI. Cholera

- हैजा; acute infection of the **small intestine**; sudden massive watery **diarrhea**, vomiting; death by **dehydration** in hours
- physical, acquired, communicable, **water-borne**, **food-borne**, **pandemic** (7); **22 March** World Water Day
- from the **Ganges delta**; 1st pandemic **1817**; 7th from **Indonesia 1961** (Africa 1971, South America 1991); 1.3–4 million cases, 21,000–143,000 deaths a year; Nepal: monsoon outbreaks
- risk: poor sanitation, unsafe water, a sick person at home, raw food, seafood, **low stomach acid**, **blood group O**
- **agent**: *Vibrio cholerae*: **comma-shaped**, **Gram-negative**, one polar flagellum; Pacini 1854; Koch 1883–84
- spread: **feco-oral** (feces, vomit, shellfish, washed raw food); incubation **12 h–5 days** (1–2 days)
- symptoms: most none or mild; **rice-water stools** (up to 1 L/h), vomiting, sunken eyes, dry mouth, loose skin, thirst, little urine, fast pulse, **low blood pressure**; **electrolyte imbalance** → cramps, **shock**
- **effects**: sticks, doesn't invade; **cholera toxin** → **cyclic AMP** stays high → **chloride channels** open → Cl^- out, Na^+ follows, **water by osmosis**; gut wall unharmed
- complications: **hypoglycemia**, **hypokalemia**, **kidney failure**
- diagnosis: **stool** culture; rapid dipstick
- prevention: toilets, hand washing, safe water, food hot; **oral cholera vaccine** (2 doses, killed; booster)

- treatment: **ORS** (Jeevan Jal; glucose + sodium taken up together, water follows); IV fluids; **zinc** for children; doxycycline, azithromycin in severe cases
- home ORS: 1 L boiled water + 6 level tsp sugar + ½ level tsp salt; no saltier than tears



How cholera toxin pours salt and water into the gut, and how ORS brings them back.

VII. Candidiasis

- fungal infection by yeasts *Candida*, mostly *C. albicans*; normally harmless on skin, mouth, gut, vagina
- overgrows when the balance is upset: **antibiotics**, diabetes, weak immunity (HIV, cancer drugs, steroids), babies and elderly, dentures, moist skin folds
- physical; acquired (from mother at birth: oral thrush); communicable only a little (own *Candida*; sexual partners; *C. auris* in hospitals)
- *C. albicans* named 1954 ("shining white"); commonest in babies, old people; **candidemia** ~9 per 100,000 a year (USA)
- agent: budding cells or **hyphae** into tissue

Types

- **cutaneous**: skin folds, **diaper rash**; red, itchy
- **vaginal** (yeast vaginitis): itching, burning, thick white **cottage-cheese** discharge; ¾ of women once
- **oral** (**thrush**): white patches, red and sore when wiped; may reach the esophagus
- **invasive** (systemic): blood (candidemia), heart lining, meninges; fever not helped by antibiotics; can kill
- **candida granuloma**: chronic mucocutaneous; crusts on skin, scalp, mouth, nails; inherited weak immunity
- incubation: hard to define; newborn thrush ~1 week
- diagnosis: by look; scraping with **KOH**, culture; invasive: blood culture, **mannan**, **anti-mannan**
- prevention: skin folds dry, cotton underwear, mouth hygiene, clean dentures, rinse after steroid inhaler, diabetes controlled, antibiotics only when needed
- treatment: **clotrimazole**, **nystatin** (creams, gels, pessaries); **fluconazole** tablets; IV drugs for invasive

3. Immunity

- **Immunology**: study of the body's resistance to infection
- immunity: **innate** (from birth) and **acquired** (after birth)

Innate (non-specific): at once, against any invader, no memory

- **A. physical/anatomical** (first line): **skin** (dead, dry, acid), **mucous membranes** (mucus, cilia), **sebum**
- **B. physiological**: **temperature** (fever), **low pH** (stomach pH 1–3), **lysozyme** (tears, saliva), **interferons** (warn cells against viruses), **complement**
- **C. phagocytic**: **neutrophils**, **monocytes** → **macrophages**
- **D. inflammatory**: **histamine**, **kinins**, **prostaglandins** → red, warm, swollen (**edema**); phagocytes come in

Acquired (adaptive, specific): against one antigen

- 4 features: **specificity**, **diversity**, **memory**, **self/non-self recognition**
- cells: **B cells** (bone marrow), **T cells** (thymus); antigen-presenting cells (macrophages, dendritic cells, B cells)
- antibodies: **IgG** (commonest, crosses placenta), **IgA** (tears, saliva, milk), **IgM** (first made), **IgD** (on B cells), **IgE** (allergy, worms)
- **humoral** (antibody-mediated): B cells → **plasma cells** → antibodies; microbes and toxins in body fluids
- **cell-mediated**: **cytotoxic T cells** kill infected, cancer and transplant cells; **helper T cells** release **cytokines**

Humoral	Cell-mediated
B cells, by antibodies	**T cells** themselves (helper, cytotoxic, regulatory), with macrophages, NK cells
plasma cells release **antibodies**; memory B cells	**no antibodies**; kill cells or release **cytokines**
microbes, toxins **outside cells**	microbes **inside cells**; **tumor** cells
antigens **unprocessed**	antigen **processed**, on **MHC**
immediate allergies	**delayed-type hypersensitivity** (tuberculin test)
no tumor killing or transplant rejection	kills tumors; **rejects transplants**

Active and passive

	Natural	Artificial
Active: own antibodies and memory; 1–2 weeks to build, long-lasting	after measles	after measles vaccine
Passive: ready-made antibodies; at once, weeks to months, no memory	mother's, across placenta and in milk	**anti-snake venom**, **rabies immunoglobulin**

3. Vaccines

- live attenuated: measles, mumps, rubella, chickenpox, yellow fever, oral polio; killed bacteria: whooping cough, old typhoid, cholera; **toxoids**: diphtheria, tetanus
- **variolation** (China, India): smallpox matter into the skin
- **Edward Jenner**, **1796**: cowpox from **Sarah Nelmes** into **James Phipps**; then smallpox, he stayed well; *vacca* = cow; **father of vaccination** (and immunology); smallpox eradicated **1980**
- **Louis Pasteur**: attenuated chicken cholera (**1879**), anthrax (1881), rabies (1885); named them vaccines; **father of microbiology**
- **World Immunization Week** 24–30 April
- preparation: **conventional** (whole microbe weakened, killed, toxin inactivated) or **biotechnology**

(**recombinant**, or the gene): faster, can't cause disease, consistent; all tested in trials

Types

- **A. live attenuated**: OPV (Sabin), MR, MMR, BCG, rotavirus, chickenpox, yellow fever, JE, nasal flu
- **B. inactivated**: IPV (Salk), whole-cell pertussis, rabies, hepatitis A, injected flu, oral cholera
- **C. toxoid**: diphtheria, tetanus
- **D. subunit**: hepatitis B (HBsAg), acellular pertussis, HPV, malaria (RTS,S, R21)
- **E. conjugate**: sugar coat + protein: Hib, PCV, TCV
- **F. nucleic acid**: DNA or mRNA: mRNA COVID-19 (2020), DNA COVID-19 (India 2021)

Generations

1. **first**: conventional, whole microbes, toxoids (measles, polio, BCG, rabies…)
2. **second**: **recombinant subunit** (**hepatitis B**, 1986), purified, conjugate
3. **third**: **DNA, mRNA** (COVID-19)
4. **fourth**: designed by computer from binding parts (some coronavirus, nanoparticle vaccines)

- every vaccine → **active** immunity; antisera (ASV, rabies, tetanus immunoglobulin) → **passive**, not vaccines
- $\mathbf{R_0}$: cases from one case (COVID-19 ~2.5; measles 12–18); share immune for herd immunity $= 1 - 1/R_0$ (60%; measles > 90%)

Vaccines against the major diseases (pathogen → type)

- measles, mumps, chickenpox, yellow fever, rubella: live attenuated
- polio: live (OPV, Sabin) and inactivated (IPV, Salk)
- influenza: inactivated (also live nasal); hepatitis A: inactivated
- hepatitis B: recombinant subunit (HBsAg)
- diphtheria, tetanus: toxoid; pertussis: inactivated whole cell or subunit
- TB: BCG, live weakened *M. bovis*
- typhoid: conjugate (TCV), live (Ty21a)
- anthrax: subunit; cholera, plague: inactivated
- malaria (*P. falciparum*): recombinant subunit, RTS,S (2021), R21 (2023)

Nepal's national schedule (2026)

When	Vaccine	Against
pregnant women	**Td** (IM, left arm)	tetanus, diphtheria
birth	**BCG** (intradermal, right arm)	TB
6 and 10 weeks	rotavirus; OPV; PCV; **DPT-HepB-Hib** (pentavalent)	rotavirus diarrhea; polio; pneumococcus; diphtheria, whooping cough, tetanus, hepatitis B, Hib
14 weeks	OPV 3; **fIPV** 1; pentavalent 3	polio; as above
9 months	fIPV 2; **MR** 1; PCV 3	polio; measles, rubella; pneumococcus
12 months	**JE**	Japanese encephalitis
15 months	MR 2; **TCV**	measles, rubella; typhoid
girls in Grade 6	**HPV**	cervical cancer

- program since **1979**; free; HPV added **February 2025**

COMMON MISTAKES

✗ Influenza and rotavirus are RG-1
✓ both cause disease in healthy people: **RG-2**.

✗ HG-2 pathogens are likely to spread
✓ HG-2 **unlikely**, HG-3 **may**, HG-4 **likely**.

✗ All five hepatitis viruses cause cirrhosis
✓ only **B, C and D**, which become chronic; A and E are cleared.

✗ Hepatitis C spreads through food and water
✓ by **blood**.

✗ TB in AIDS is caused by *M. avium*
✓ TB is *M. tuberculosis*; *M. avium* is a different infection.

✗ *M. tuberculosis* is Gram-positive
✓ call it **acid-fast** (Ziehl–Neelsen).

✗ MDR therapy is the standard TB treatment
✓ **MDR-TB** is **multidrug-resistant** TB.

✗ T cells secrete antibodies, or "cytokinins"
✓ antibodies only from **B (plasma) cells**; T cells release **cytokines**.

✗ Toxoid, subunit and DNA vaccines are passive
✓ all vaccines give **active** immunity; only ready-made antibodies are passive.

✗ Rubella vaccine is inactivated; BCG is from *M. tuberculosis*
✓ rubella is **live attenuated**; BCG is weakened *M. bovis*.

✗ DNA vaccines against malaria, HIV, Ebola are in use
✓ still in trials; malaria vaccines are **subunit**.

✗ Malaria is pandemic
✓ **endemic** in the Tarai.