BP802T · B.Pharm Semester VIII · Theory Notes

Clinical Pharmacotherapeutics

Unit V — Hematological Therapeutics (3 hours)

Unit V (3 hours)

Pills & Python Notes

From-zero teaching standard: every technical term is defined before use.

Syllabus coverage: Unit V (3 hours).

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CHAPTER 14: Anemias: Iron Deficiency, Megaloblastic and Hemolytic

1. Learning Objectives

After studying this chapter, the student will be able to:

- Define anemia and its basic measurements (haemoglobin, RBC indices conceptually).
- Classify anemias by cause in a table (decreased production, increased loss/destruction, nutritional).
- Describe causes, clinical manifestations (including koilonychia and pica), and management by drug class for iron deficiency anemia.
- Compare vitamin B12 deficiency versus folate deficiency (megaloblastic anemia), including pernicious anemia.
- Explain hemolytic anemia: intrinsic versus extrinsic causes, with sickle cell disease, thalassemia, and G6PD deficiency concepts.
- Outline management principles by class for each anemia type.
- Describe the pharmacist's role in iron/B12/folate counselling, adherence, and India's anemia programmes.

2. Definitions

- **Anemia** — a condition in which the blood has too few red blood cells (RBCs), or too little haemoglobin in them, so the blood carries less oxygen than the body needs. The person feels tired, weak, and pale.
- **Haemoglobin (Hb)** — the iron-containing protein inside red blood cells that picks up oxygen in the lungs and delivers it to tissues. Measured in grams per decilitre (g/dL); low Hb defines anemia.
- **Red blood cell (RBC)** — the disc-shaped blood cell that carries oxygen; made in the bone marrow, lives about 120 days.
- **Microcytic** — abnormally small red blood cells (as in iron deficiency). **Macrocytic** — abnormally large red blood cells (as in B12/folate deficiency). **Normocytic** — normal-sized red cells.
- **Hypochromic** — red cells with too little haemoglobin, looking pale in the centre (iron deficiency). **Hyperchromic** is rarely a true increase; macrocytic cells may look fuller.
- **MCV (mean corpuscular volume)** — the average size of red blood cells; low MCV = microcytic, high MCV = macrocytic. Used conceptually to classify anemia.
- **Iron deficiency anemia (IDA)** — anemia caused by too little iron to make haemoglobin, most often from blood loss, poor intake, or poor absorption.
- **Megaloblastic anemia** — anemia with large, immature red cells (**megaloblasts**) caused by defective DNA synthesis, most often from vitamin B12 or folate deficiency.
- **Pernicious anemia** — an autoimmune disease in which the stomach cannot absorb vitamin B12 (lack of intrinsic factor), causing B12 deficiency.

- **Intrinsic factor** — a stomach protein that binds vitamin B12 so it can be absorbed in the intestine; without it, B12 passes out unabsorbed.
- **Hemolytic anemia** — anemia caused by red blood cells being destroyed (haemolysed) faster than the bone marrow can replace them.
- **Haemolysis** — the bursting open of red blood cells, releasing haemoglobin.
- **Jaundice** — yellowing of skin and eyes from excess bilirubin; in haemolysis, bilirubin rises because broken red cells release haem pigment.
- **Sickle cell disease** — an inherited disorder in which abnormal haemoglobin (HbS) makes red cells stiffen into sickle shapes that block small blood vessels and break easily.
- **Thalassemia** — an inherited disorder in which the body makes too little of one globin chain of haemoglobin, producing small, fragile red cells.
- **G6PD deficiency** — an inherited lack of the enzyme glucose-6-phosphate dehydrogenase, which protects red cells from oxidative damage; certain drugs, infections, or foods trigger sudden haemolysis.
- **Koilonychia** — spoon-shaped nails (nails curve upward like spoons), a classic sign of chronic iron deficiency.
- **Pica** — craving and eating non-food substances (clay, chalk, ice, raw rice), seen in iron deficiency.
- **Glossitis** — inflamed, sore, smooth tongue (seen in iron and B12 deficiency). **Angular cheilitis** — cracks at the corners of the mouth (iron deficiency).

3. Terminology Table

Term	Simple Meaning
Pallor	Paleness of skin, conjunctiva, palms — the commonest sign of anemia
Fatigue	Tiredness disproportionate to activity — the commonest symptom
Dyspnoea on exertion	Breathlessness with activity because blood carries less oxygen
Tachycardia	Fast heartbeat — the heart pumps faster to compensate for low oxygen
Ferritin	The body's iron storage protein; low ferritin = empty iron stores
Transferrin saturation	How full the blood's iron-carrying protein is; low in iron deficiency
Reticulocyte	A young red blood cell; high count means the marrow is working hard (as in haemolysis)
Bilirubin (indirect)	Rises when red cells break down in large numbers
LDH	An enzyme released when cells (including red cells) break open; raised in haemolysis
Haptoglobin	A protein that mops up free haemoglobin; low in haemolysis
Splenomegaly	Enlarged spleen — common in chronic haemolytic anemias

Term	Simple Meaning
Vaso-occlusive crisis	Painful episode in sickle cell disease when sickled cells block blood flow
Chelation therapy	Drugs that bind and remove excess iron (needed in thalassemia from repeated transfusions)

4. Detailed Explanation

4.1 Anemia: the big picture

Think of blood as a delivery fleet: red cells are the trucks, haemoglobin is the cargo hold, oxygen is the cargo. Anemia means too few trucks, or trucks with tiny cargo holds. Causes fall into three buckets: (1) **not enough production** — missing raw materials (iron, B12, folate) or marrow failure; (2) **loss** — bleeding (heavy periods, piles, hookworm, ulcers, frequent blood donation); (3) **destruction** — haemolysis (inherited defects or external attackers). Symptoms depend on speed and severity: gradual anemia causes fatigue, pallor, breathlessness on exertion, palpitations, headache, and poor concentration; rapid or severe anemia can cause chest pain, fainting, and heart strain.

4.2 Iron deficiency anemia (IDA)

Why iron matters. Iron is the core atom of haem (the oxygen-gripping part of haemoglobin). No iron → no haem → small, pale red cells (microcytic hypochromic).

Causes. (a) **Blood loss** — the commonest cause in adults: heavy menstrual bleeding, bleeding piles, hookworm infestation (very relevant in India), stomach ulcers, frequent nosebleeds, blood donation without replacement. (b) **Increased demand** — pregnancy, lactation, adolescence (growth spurt). (c) **Poor intake/absorption** — diets low in iron, excess tea/coffee with meals (tannins block absorption), antacids, stomach surgery, coeliac-type malabsorption.

Clinical features. General anemia symptoms (fatigue, pallor, breathlessness, palpitations) PLUS iron-specific clues: **koilonychia** (spoon-shaped nails), **pica** (craving clay/chalk/ice), **angular cheilitis** (mouth-corner cracks), **glossitis** (sore smooth tongue), brittle nails and hair loss, restless legs. Long-standing IDA in children impairs growth and learning.

Diagnosis (conceptual). Low Hb with microcytic hypochromic red cells (low MCV); low ferritin (empty stores) and low transferrin saturation confirm iron deficiency; always look for the SOURCE of loss (stool test for blood/worms, menstrual history, GI evaluation where indicated).

Management by class. (1) **Treat the cause** — deworming, menstrual management, ulcer treatment — or iron therapy fails. (2) **Oral iron salts** (ferrous sulfate, ferrous fumarate, ferrous ascorbate class): first-line; counsel to take on an empty stomach or with vitamin C for absorption, expect dark stools (harmless), and manage constipation/nausea; continue for weeks after Hb normalises to refill stores (as per current guidelines — confirm latest edition). (3) **Parenteral iron** (IV iron class): when oral iron is not tolerated, absorption is poor, blood loss is ongoing, or anemia is severe — given in hospital/day-care settings. (4) **Dietary advice**: iron-rich foods (green leafy vegetables, jaggery, ragi, meat for non-vegetarians), vitamin C with meals, avoid tea/coffee with iron tablets. (5) Transfusion only for severe/symptomatic anemia per clinical judgement.

4.3 Megaloblastic anemia (B12 vs folate)

Why B12 and folate matter. Both vitamins are needed to make DNA. Without them, red-cell precursors grow large but cannot divide properly → big, fragile, immature cells (**megaloblasts**, high MCV —

macrocytic anemia). White cells and platelets can also fall.

Vitamin B12 deficiency — causes. Pernicious anemia (autoimmune destruction of stomach parietal cells → no intrinsic factor → B12 cannot be absorbed); strict vegetarian/vegan diets without B12 sources (highly relevant in India); stomach or ileal surgery; long-term metformin or acid-suppressing therapy reducing absorption; tapeworm/fish-related rare causes.

Folate deficiency — causes. Poor dietary intake (overcooked vegetables destroy folate), increased demand (pregnancy — critical for preventing neural tube defects), alcoholism, certain drugs (methotrexate, trimethoprim, some anti-epileptics interfere with folate), malabsorption.

B12 vs folate — the crucial comparison. Both cause macrocytic anemia with glossitis and fatigue. The difference: **B12 deficiency ALSO damages nerves** — numbness/tingling in hands and feet, unsteady walking, memory problems — and nerve damage can become PERMANENT if treatment is delayed. Folate deficiency does not cause nerve damage. **Exam-critical rule: never treat B12-deficiency anemia with folate alone** — folate will correct the blood picture and mask the anemia while nerve damage silently progresses. Always check B12 status (or treat B12) when megaloblastic anemia is found.

Management by class. Vitamin B12 replacement (oral high-dose or intramuscular cyanocobalamin/hydroxocobalamin class): parenteral for pernicious anemia, neurological symptoms, or severe deficiency; oral for mild dietary deficiency; pernicious anemia needs LIFELONG therapy. **Folate replacement** (folic acid class): for proven folate deficiency; in pregnancy, folic acid is given to prevent neural tube defects (as per antenatal guidelines). Always exclude/treat coexisting B12 deficiency before folate-only therapy.

4.4 Hemolytic anemias (overview)

Intrinsic (the red cell itself is defective) vs extrinsic (something outside attacks normal red cells).

- **Intrinsic: sickle cell disease** — HbS polymerises when oxygen is low → cells sickle → block microvessels (painful vaso-occlusive crises, hand-foot syndrome in children, stroke, chest syndrome) and break easily (chronic haemolysis, jaundice, gallstones). **Thalassemia** (alpha or beta) — too little globin chain → small fragile cells → anemia from infancy/childhood; severe beta-thalassemia needs regular blood transfusions, which cause iron overload requiring **iron chelation therapy** (deferoxamine/deferiprone/deferasirox class). **Hereditary spherocytosis** — round fragile cells removed by the spleen. **G6PD deficiency** — normal life until a trigger (certain drugs like primaquine-class antimalarials, rasburicase, infections, fava beans) causes sudden oxidative haemolysis with dark urine and jaundice.
- **Extrinsic:** autoimmune haemolytic anemia (antibodies attack red cells), mismatched blood transfusion, malaria (parasites burst red cells), mechanical heart valves, certain infections/toxins.

Clues to haemolysis. Jaundice, dark urine, enlarged spleen, gallstones at a young age, family history, and labs showing high reticulocytes (marrow working overtime), raised indirect bilirubin and LDH, low haptoglobin.

Management principles by category. Stop/remove the trigger (drugs in G6PD deficiency, treat autoimmune cause); folic acid supplementation (high red-cell turnover consumes folate); transfusions for severe anemia; **hydroxyurea class** reduces crises in sickle cell disease (as per current guidelines); vaccinations and penicillin prophylaxis in sickle cell children (spleen dysfunction → infection risk); iron chelation for transfusion iron overload in thalassemia; splenectomy considered in selected chronic cases (with vaccination first); genetic counselling for families.

5. Classifications

Table 5.1 — Anemia classification by cause

Mechanism	Examples	Red cell picture
Decreased production — nutritional	Iron deficiency; B12 deficiency; folate deficiency	Microcytic hypochromic (iron); macrocytic (B12/folate)
Decreased production — marrow failure	Aplastic anemia; marrow infiltration; chronic kidney disease (low erythropoietin)	Usually normocytic
Blood loss	Acute bleed; chronic slow loss (piles, hookworm, heavy periods)	Microcytic hypochromic if chronic (iron depleted)
Increased destruction (haemolysis) — inherited	Sickle cell, thalassemia, G6PD deficiency, spherocytosis	Normocytic with high reticulocytes
Increased destruction — acquired	Autoimmune, transfusion reaction, malaria, mechanical valves	Normocytic with high reticulocytes
Anemia of chronic disease	TB, chronic kidney disease, cancers, chronic inflammation	Usually normocytic, mild

Table 5.2 — B12 deficiency vs folate deficiency

Feature	Vitamin B12 deficiency	Folate deficiency
Red cells	Macrocytic (megaloblastic)	Macrocytic (megaloblastic)
Nerve damage	YES — numbness, unsteady gait, memory issues; may become permanent	NO
Common causes	Pernicious anemia, vegetarian diet, gut surgery, metformin	Poor diet, pregnancy demand, alcoholism, antifolate drugs
Treatment	B12 replacement (IM or oral; lifelong in pernicious anemia)	Folic acid; never folate-alone without checking B12
Key danger	Masking with folate alone while nerves deteriorate	Neural tube defects if deficient in pregnancy

Table 5.3 — Hemolytic anemias: intrinsic vs extrinsic

Type	Examples	Key trigger/clue
Intrinsic — haemoglobin defect	Sickle cell disease	Pain crises, sickle-shaped cells
Intrinsic — globin quantity defect	Thalassemia (alpha/beta)	Microcytic anemia from childhood, family history
Intrinsic — enzyme defect	G6PD deficiency	Sudden haemolysis after drugs/infection/fava beans
Intrinsic — membrane defect	Hereditary spherocytosis	Round cells, spleen removes them
Extrinsic — immune	Autoimmune haemolytic anemia	Antibodies coat red cells
Extrinsic — mechanical/infective	Faulty heart valve, malaria, transfusion mismatch	Schistocytes (fragmented cells), parasites

6. Mechanisms / Pathophysiology Flow

Flow 6.1 — Iron deficiency: from empty stores to anemia

```
Blood loss / poor intake / poor absorption / increased demand (pregnancy)
        |
        v
Body iron stores (ferritin) empty first --> still normal Hb (hidden stage)
        |
        v
Not enough iron for haem production --> red cells made small and pale
        |
        v
Microcytic hypochromic anemia: fatigue, pallor, koilonychia, pica
        |
  (Replace iron AND fix the cause, or the tank empties again)
```

Flow 6.2 — Megaloblastic anemia: the DNA bottleneck

```
B12 or folate deficiency --> DNA synthesis slows in marrow precursors
        |
        v
Cell grows (cytoplasm) but nucleus cannot divide properly
        |
        v
Giant immature MEGALOBLASTS --> many die in marrow (ineffective production)
        |
        v
Few, large, fragile red cells reach blood --> macrocytic anemia (high MCV)
        |
        +---> B12 deficiency ONLY: myelin of nerves also fails
                --> numbness, unsteady walking, memory loss (may become permanent)
```

Flow 6.3 — Haemolysis: destruction outruns production

```
Red cells destroyed too fast (defective cells / antibodies / parasites / triggers)
        |
        v
Haemoglobin released --> broken into bilirubin --> JAUNDICE
        |
        v
Bone marrow works overtime --> many reticulocytes (young cells) in blood
        |
        v
If destruction > production --> anemia + enlarged spleen (filter overworked)
```

Flow 6.4 — Sickle cell crisis

```
Low oxygen / dehydration / infection / cold
        |
        v
HbS molecules stick together (polymerise) inside red cells
        |
        v
Cells stiffen into SICKLE shapes --> jam in tiny blood vessels
        |
        v
Tissue downstream loses blood --> severe PAIN crisis (+ organ damage risk)
```

Flow 6.5 — G6PD trigger haemolysis

```
G6PD-deficient red cells (poor antioxidant defence)
        |
        v
Trigger: primaquine-class drug / infection / fava beans --> oxidative stress
        |
        v
Haemoglobin denatures --> red cells burst --> sudden anemia + dark urine + jaundice
```

7. Diagrams / Flowcharts

Diagram 7.1 — Approaching an anemia case (diagnostic logic)

```
Low Hb found
        |
        v
Check MCV (red cell size)
        |
        +---> LOW (microcytic) --> think IRON deficiency / thalassemia
        |       --> check ferritin, look for blood loss source
        |
        +---> HIGH (macrocytic) --> think B12 / FOLATE deficiency
        |       --> check B12 and folate; NEVER folate-alone before B12 checked
        |
        +---> NORMAL (normocytic) --> think blood loss (acute), haemolysis,
                chronic disease, marrow problem
                --> check reticulocytes: HIGH = haemolysis/bleeding; LOW = production failure
```

Diagram 7.2 — IDA management ladder

```
Confirm iron deficiency (low ferritin) + find the cause
        |
        v
Treat cause (deworm, menstrual care, ulcer therapy)
        +
Oral iron salts (with vitamin C; avoid tea/coffee with dose)
        |
        v
Hb rises in weeks --> CONTINUE iron to refill stores (as per guidelines)
        |
   intolerant / malabsorption / severe --> parenteral (IV) iron in supervised setting
```

Diagram 7.3 — Suspected haemolysis workup (conceptual)

```
Anemia + jaundice / dark urine / enlarged spleen / family history
        |
        v
Reticulocytes HIGH --> haemolysis likely
        |
        v
Bilirubin (indirect) up + LDH up + haptoglobin low --> confirms haemolysis
        |
        v
Blood smear clues: sickle cells / spherocytes / fragments / parasites
        |
        v
Targeted tests: Hb electrophoresis (sickle/thalassemia), G6PD assay, Coombs test
```

8. Infographic Concepts (Text Boxes)

```
+-----------------------------------------------------------+
| THE 3 QUESTIONS OF ANEMIA                                 |
| 1. SIZE? Small (iron), Large (B12/folate), Normal         |
|    (loss/destruction/chronic disease).                    |
| 2. MAKING OR LOSING? Marrow failing, blood leaking,       |
|    or cells bursting?                                     |
| 3. WHY? Find the cause — iron tablets can't fix a         |
|    bleeding pile or a hookworm.                           |
+-----------------------------------------------------------+

+-----------------------------------------------------------+
| SPOON NAILS + CLAY CRAVING = IRON DEFICIENCY              |
| Koilonychia (spoon-shaped nails) and pica (eating         |
| clay/chalk/ice) are classic bedside clues of chronic     |
| iron deficiency — ask about them in every anemia case.    |
+-----------------------------------------------------------+

+-----------------------------------------------------------+
| THE FOLATE TRAP                                           |
| Giving folate alone for megaloblastic anemia without      |
| checking B12 fixes the blood but lets nerve damage        |
| march on silently. ALWAYS rule out B12 deficiency first.  |
+-----------------------------------------------------------+

+-----------------------------------------------------------+
| G6PD: KNOW BEFORE YOU TRIGGER                             |
| Primaquine-class antimalarials and some other drugs       |
| can burst red cells in G6PD deficiency. Test first,       |
| warn about dark urine, and keep an avoidance list.        |
+-----------------------------------------------------------+
```

9. Tables (Comparisons, Summaries)

Table 9.1 — Three anemias head-to-head

Feature	Iron deficiency	Megaloblastic (B12/folate)	Hemolytic
Red cell size	Small (microcytic)	Large (macrocytic)	Usually normal
Colour	Pale (hypochromic)	Normal/fuller	Normal
Reticulocytes	Low	Low	HIGH
Bilirubin	Normal	Normal/mild	Raised (indirect)
Signature signs	Koilonychia, pica, angular cheilitis	Glossitis; nerve signs (B12 only)	Jaundice, dark urine, splenomegaly
Core treatment class	Iron salts (oral/IV) + treat cause	B12 replacement ± folic acid	Remove trigger; folate; transfusion/chelation/disease-specific

Table 9.2 — Iron therapy counselling points

Point	Detail
How to take	Empty stomach or with vitamin C; avoid tea/coffee/antacids with the dose
What to expect	Dark stools (harmless); nausea/constipation manageable; Hb rises in weeks
Duration	Continue after Hb normalises to refill stores (as per current guidelines)

Point	Detail
Warning signs	Severe abdominal pain, vomiting blood, black tarry stools with pain — seek care
Children	Keep iron syrups out of reach — overdose is dangerous

Table 9.3 — Sickle cell vs thalassemia (conceptual)

Feature	Sickle cell disease	Beta-thalassemia major
Defect	Abnormal haemoglobin (HbS) shape	Too little beta-globin chain
Red cells	Sickle under low oxygen	Small, fragile from early life
Main crises	Painful vaso-occlusive crises, chest syndrome, stroke	Severe anemia needing regular transfusion
Key long-term drug class	Hydroxyurea (crisis reduction); folate	Iron chelators (transfusion iron overload)
Prevention focus	Vaccines, penicillin prophylaxis (children), hydration	Genetic counselling, prenatal screening

10. Worked Examples (Patient-Case Vignettes)

Case 1 — IDA. A 26-year-old woman has 6 months of fatigue, pallor, and breathlessness climbing stairs; she craves eating chalk (pica) and her nails are spoon-shaped (koilonychia). History: heavy menstrual periods. Labs: low Hb, microcytic hypochromic cells, low ferritin. Interpretation: iron deficiency anemia from menstrual blood loss. Management principles: gynaecology review for menorrhagia; oral iron salts with counselling (vitamin C, avoid tea with dose, dark stools harmless, continue after Hb normalises to refill stores); dietary advice; deworming as per local practice; recheck Hb and ferritin as advised.

Case 2 — B12 deficiency. A 55-year-old strict vegetarian man has fatigue, sore smooth tongue, and 3 months of numbness/tingling in the feet with unsteady walking. Labs: macrocytic anemia, low B12. Interpretation: vitamin B12 deficiency with neurological involvement. Management principles: B12 replacement — parenteral preferred with nerve symptoms (as per current guidelines — confirm latest edition); start promptly because delay risks permanent nerve damage; do NOT treat with folate alone; lifelong therapy if pernicious anemia confirmed; dietary counselling on B12 sources/supplements.

Case 3 — G6PD haemolysis. A 20-year-old man develops sudden fatigue, jaundice, and dark urine 3 days after starting a primaquine-class antimalarial for vivax radical cure. Interpretation: acute haemolysis, likely G6PD deficiency triggered by the drug. Management principles: stop the trigger drug immediately; urgent medical assessment; supportive care and transfusion if severe; confirm G6PD status; counsel to carry a drug-avoidance list and inform every prescriber/pharmacist of G6PD deficiency lifelong.

Case 4 — Thalassemia child. A 3-year-old with known beta-thalassemia major receives blood transfusions every 3–4 weeks and now has signs of iron overload. Pharmacist's role: explain why chelation therapy is needed (each transfusion adds iron the body cannot excrete; excess iron damages heart, liver, glands); counsel on chelator adherence and administration; monitor growth and reinforce transfusion schedule adherence; support the family with genetic counselling referral for future pregnancies.

11. Analogies

- **Anemia:** like a city with too few delivery trucks (red cells) — shops (tissues) run short of goods (oxygen); everything slows down and the city feels exhausted.

- **Iron deficiency:** like building houses without bricks — the marrow keeps trying, but without iron "bricks" it makes tiny, flimsy houses (small pale cells).
- **Koilonychia:** nails curving up like spoons — the body's way of waving a flag that says "iron empty".
- **Pica:** like a confused GPS recalculating — the iron-starved brain sends bizarre cravings (clay, chalk, ice) instead of food signals.
- **Megaloblastic anemia:** like a factory where the assembly line jams — workers keep adding material (big cells) but the cutting machine (DNA division) is broken, so giant unfinished products pile up.
- **The folate trap:** like painting over a cracked wall — the surface looks fixed (blood improves) while the foundation (nerves) keeps crumbling.
- **Haemolysis:** like water balloons popping faster than the factory makes them — no matter how hard the marrow works, the fleet keeps shrinking.
- **Sickle crisis:** like rigid buses jamming a narrow lane — stiff sickled cells block the road and everything behind them suffers.
- **G6PD deficiency:** like a phone with no protective case — fine in normal use, but one drop (trigger drug/infection) shatters the screen.

12. Pharmacy Relevance (What the Pharmacist Does)

- **Detect and refer:** pallor + fatigue + pica/koilonychia → suspect IDA and refer for Hb/ferritin testing; numbness + macrocytic picture → urgent B12 evaluation (nerve damage is time-critical).
- **Iron counselling:** how/when to take iron, vitamin C pairing, tea/coffee separation, dark stools are harmless, constipation management, full duration to refill stores, and keep syrups away from children.
- **Treat the cause:** remind prescribers/patients that deworming, menstrual management, and GI evaluation matter as much as the iron tablet.
- **B12/folate safety:** never dispense folate-alone for megaloblastic anemia without B12 assessment; counsel vegetarians on B12 sources; ensure pernicious anemia patients understand lifelong therapy.
- **G6PD vigilance:** before dispensing primaquine-class drugs, confirm G6PD testing was done; maintain an avoidance list for G6PD-deficient patients (trigger drugs, fava beans); counsel on dark-urine warning signs.
- **Thalassemia/sickle cell support:** chelator and hydroxyurea adherence counselling, vaccination reminders, pain-crisis action plans, transfusion schedule support.
- **Pregnancy care:** ensure antenatal iron-folic acid supplementation is taken correctly; counsel on neural-tube-defect prevention with folate.
- **Programme linkage:** connect patients to government anemia-control services (antenatal programmes, school/adolescent supplementation schemes) — name generically as national anemia control initiatives.

13. India Context

- Anemia is a massive public health problem in India — affecting large proportions of women of reproductive age, pregnant women, adolescent girls, and young children, driven by iron-poor diets, hookworm infestation, frequent pregnancies, and menstrual blood loss.
- India runs national anemia-control initiatives providing **iron-folic acid supplementation** to pregnant women, lactating mothers, adolescents, and young children through antenatal clinics, anganwadis, and schools, plus **deworming** programmes — pharmacists should know these exist and guide eligible patients to them (describe generically; confirm current programme names locally).
- Strict vegetarian diets are common, making **vitamin B12 deficiency** widespread and under-recognised; pharmacists should proactively counsel vegetarians on B12 sources and testing.
- **Thalassemia and sickle cell disease** have high prevalence in several Indian communities and tribal belts; carrier screening, premarital counselling, and prenatal diagnosis programmes operate in many states — pharmacists support adherence to transfusion/chelation schedules and family counselling referrals.
- **G6PD deficiency** is relevant wherever primaquine-class radical cure for vivax malaria is used (see Chapter 13) — testing before treatment is programme-linked in many areas.
- Excess tea consumption with meals is a culturally common absorption blocker worth counselling about.

14. Key Points

- Anemia = too few red cells or too little haemoglobin → less oxygen delivery → fatigue, pallor, breathlessness.
- Classify by MCV: microcytic (iron deficiency, thalassemia), macrocytic (B12/folate), normocytic (loss, haemolysis, chronic disease).
- IDA: causes = blood loss, demand, poor intake/absorption; signs = koilonychia, pica, angular cheilitis; treat cause + iron salts (oral first), continue to refill stores.
- Megaloblastic: B12 vs folate — both macrocytic, but ONLY B12 damages nerves; never folate-alone without checking B12; pernicious anemia needs lifelong B12.
- Hemolytic: destruction > production; intrinsic (sickle, thalassemia, G6PD, spherocytosis) vs extrinsic (immune, malaria, mechanical); clues = jaundice, dark urine, high reticulocytes, splenomegaly.
- Sickle cell: vaso-occlusive pain crises, hydroxyurea-class prevention; thalassemia major: transfusions + iron chelation; G6PD: avoid triggers.
- Pharmacists: counselling on iron/B12 administration, G6PD trigger vigilance, adherence support, and linkage to national anemia programmes.

15. Common Confusions (with Clarifications)

- **"All anemias need iron tablets."** No — iron helps only iron deficiency; giving iron for B12 deficiency or thalassemia is useless and in thalassemia can worsen iron overload.
- **"Folate can substitute for B12."** Dangerous — folate masks the anemia while B12-related nerve damage progresses irreversibly.

- **"Dark stools on iron mean bleeding."** Dark stools are an expected harmless effect of oral iron; worry only with pain, vomiting blood, or tarry stools with symptoms.
- **"Thalassemia minor needs iron."** Usually not iron-deficient — microcytic cells here are from the globin defect; unnecessary iron adds to overload risk.
- **"G6PD deficiency causes constant anemia."** Most patients are fine until a trigger (drug, infection, fava beans) causes sudden haemolysis.
- **"Sickle cell trait equals sickle cell disease."** Trait (carrier) is usually mild/asymptomatic; disease (two abnormal genes) causes crises — genetic counselling clarifies risk.
- **"One Hb test is enough to diagnose the type."** Hb confirms anemia; MCV, ferritin, B12/folate, reticulocytes, and smear identify the type and cause.

16. Common Mistakes (Exam Traps)

- Writing "iron for all anemias" — match treatment to mechanism; iron in thalassemia major without deficiency is wrong.
- Forgetting the folate-trap rule: folate-alone in undiagnosed B12 deficiency.
- Mixing up koilonychia (iron deficiency, spoon nails) with clubbing (not an anemia sign).
- Confusing relapse/recrudescence concepts from malaria chapter with anemia — keep chapters separate.
- Omitting "treat the cause" in IDA answers (deworming, menstrual history, GI loss).
- Stating iron doses or durations specifically — keep to classes and "as per current guidelines — confirm latest edition".
- Listing chelation for IDA — chelators REMOVE iron; they are for transfusion iron overload, the opposite problem.
- Forgetting G6PD testing before primaquine-class drugs (links Chapters 13 and 14).

17. Mnemonics

- **IDA signs — "Pica, Koilonychia, Cheilitis — PKC": P**ica (clay craving), **K**oilonychia (spoon nails), **C**heilitis (mouth-corner cracks).
- **Micro vs macro — "Small = iS (iron Small); Large = BLF (B12/folate Large)".**
- **Folate trap — "Folate Fixes blood, Forgets nerves — check B12 FIRST".**
- **Haemolysis labs — "BIL-R": B**ilirubin (indirect) up, **L**DH up, **R**eticulocytes up, haptoglobin down.
- **Intrinsic haemolysis — "STGS": S**ickle, **T**halassemia, **G**6PD, **S**pherocytosis.
- **IDA causes — "BLIND": B**leeding, **L**oss (menstrual), **I**ntake poor, **N**eed increased (pregnancy), **D**ysabsorption (gut).

18. Exam Summary

Anemia is defined by too few red blood cells or too little haemoglobin, classified by red-cell size (MCV) into microcytic, macrocytic, and normocytic types reflecting decreased production, blood loss, or increased destruction. Iron deficiency anemia — from blood loss, increased demand, or poor intake/absorption — presents with fatigue, pallor, koilonychia, pica, and angular cheilitis, and is managed by treating the cause plus oral iron salts (parenteral iron when needed), continued until stores refill. Megaloblastic anemia from B12 or folate deficiency produces macrocytic cells; B12 deficiency additionally causes potentially permanent nerve damage, pernicious anemia needs lifelong B12, and folate must never be given alone without excluding B12 deficiency. Hemolytic anemias arise from intrinsic red-cell defects (sickle cell disease with vaso-occlusive crises, thalassemia needing transfusion plus iron chelation, G6PD deficiency with trigger-induced haemolysis) or extrinsic attacks; clues include jaundice, dark urine, high reticulocytes, and splenomegaly. Pharmacists counsel on iron/B12 administration, guard against the folate trap and G6PD triggers, support chelator and hydroxyurea adherence, and link patients to India's national anemia-control and supplementation programmes.

19. One-Minute Revision

- Anemia: low RBC/Hb → fatigue, pallor, breathlessness; size it by MCV.
- Microcytic = iron deficiency (koilonychia, pica) or thalassemia; treat cause + iron.
- Macrocytic = B12/folate; B12 damages nerves; never folate-alone without B12 check; pernicious anemia = lifelong B12.
- Hemolytic: destruction > production; jaundice + dark urine + high reticulocytes; intrinsic (sickle, thalassemia, G6PD) vs extrinsic.
- Sickle: pain crises, hydroxyurea; thalassemia major: transfusions + chelation; G6PD: avoid triggers.
- Pharmacist: iron counselling, folate-trap vigilance, G6PD list, programme linkage.

20. MCQs

1 Koilonychia (spoon-shaped nails) is a classic sign of:

a) B12 deficiency b) Iron deficiency anemia c) Thalassemia d) Aplastic anemia

1 Pica refers to:

a) Yellowing of eyes b) Craving non-food substances like clay or chalk c) Spoon-shaped nails d) Enlarged spleen

1 Microcytic hypochromic red cells most suggest:

a) Folate deficiency b) Iron deficiency c) B12 deficiency d) Acute blood loss

1 Nerve damage (numbness, unsteady gait) in megaloblastic anemia points to deficiency of:

a) Iron b) Folate c) Vitamin B12 d) Vitamin C

1 The "folate trap" means:

a) Folate cures B12 deficiency b) Folate alone masks anemia while B12 nerve damage progresses c) Folate causes nerve damage d) Folate prevents iron absorption

1 Pernicious anemia is caused by:

a) Poor dietary iron b) Autoimmune loss of intrinsic factor impairing B12 absorption c) Hookworm infestation d) Excess folate intake

1 High reticulocyte count in anemia suggests:

a) Marrow failure b) Hemolysis or acute blood loss with marrow response c) Iron deficiency d) B12 deficiency

1 Sudden haemolysis with dark urine after a primaquine-class drug suggests:

a) Iron deficiency b) G6PD deficiency c) Pernicious anemia d) Thalassemia minor

1 Vaso-occlusive pain crises occur in:

a) Iron deficiency anemia b) Sickle cell disease c) Folate deficiency d) Aplastic anemia

1 Iron chelation therapy is indicated in:

a) Iron deficiency anemia b) Transfusion-related iron overload in thalassemia major c) Pernicious anemia d) G6PD deficiency

Answer Key: 1-b, 2-b, 3-b, 4-c, 5-b, 6-b, 7-b, 8-b, 9-b, 10-b

21. Viva / Application Questions

1 **Q: A patient has macrocytic anemia. Why must you check B12 before giving folic acid?**

A: Because folic acid corrects the blood picture but does nothing for B12-related nerve damage, which then progresses silently and can become permanent — the "folate trap". Confirm B12 status and treat B12 deficiency first or together.

1 **Q: How do you counsel a patient starting oral iron tablets?**

A: Take on an empty stomach or with vitamin C (avoid tea/coffee/antacids with the dose); expect harmless dark stools; manage constipation with fluids/fibre; continue for the full prescribed duration even after feeling better to refill iron stores; keep syrups away from children.

1 **Q: What bedside clues distinguish hemolytic anemia from iron deficiency?**

A: Hemolysis shows jaundice, dark urine, enlarged spleen, and lab signs of destruction (high reticulocytes, raised indirect bilirubin/LDH, low haptoglobin); iron deficiency shows koilonychia, pica, angular cheilitis with microcytic pale cells and low ferritin.

1 **Q: A G6PD-deficient patient needs vivax malaria radical cure. What is your role?**

A: Ensure G6PD testing is done before any primaquine-class drug; if deficient, alert the prescriber (alternative strategies per guidelines); counsel the patient on trigger avoidance, dark-urine warning signs, and carrying a drug-avoidance list lifelong.

1 **Q: Why does a thalassemia major child on regular transfusions need chelation therapy?**

A: Each transfusion adds iron the body cannot excrete; accumulated iron damages the heart, liver, and endocrine glands. Chelators bind and remove excess iron, so adherence to chelation is as life-saving as

the transfusions themselves.

22. References

- Standard pharmacotherapeutics and clinical pharmacy textbooks (consult latest editions).
- Standard haematology textbooks for anemia classification, iron metabolism, and hemolytic disorders (consult latest editions).
- India's national anemia-control and iron-folic acid supplementation programme documents — as per current guidelines, confirm latest edition.
- Current national/international guidelines for anemia, thalassemia, and sickle cell disease management — as per current guidelines, confirm latest edition.
- Standard pharmacology textbooks for iron preparations, B12/folate, chelators, and hydroxyurea drug classes (consult latest editions).