🧬 VITAMIN B12 (COBALAMIN) DEFICIENCY ANEMIA

Definition:

Anemia caused by vitamin B12 deficiency, leading to impaired DNA synthesis and megaloblastic changes. Unlike folate deficiency, it often causes neurologic symptoms.

🥩 Causes / Risk Factors

1. Dietary deficiency
    - Rare; mainly in strict vegans who avoid milk and eggs
2. Impaired absorption (most common)
    - Pernicious anemia: autoimmune attack on parietal cells → ↓ intrinsic factor (IF) → ↓ B12 absorption
    - Gastrectomy: loss of IF-producing cells

- Ileal resection / ileal disorders: loss of IF-B12 complex absorption (e.g., Crohn disease, environmental enteropathy, Whipple disease)
- Achlorhydria / gastric atrophy: ↓ acid & pepsin → B12 not freed from food proteins

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🔬 Absorption Pathway

1. Stomach: pepsin frees B12 → binds haptocorrin
2. Duodenum: pancreatic proteases release B12 → binds intrinsic factor (IF)
3. Ileum: IF-B12 complex recognized by cubilin receptor → endocytosis
4. Plasma: B12 binds transcobalamin II → delivered to liver, bone marrow, and other cells
5. Storage: liver stores sufficient B12 for 5-20 years, so deficiency develops slowly

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🧬 Pathogenesis

- B12 deficiency → impaired thymidine (dTMP) synthesis → defective DNA replication → megaloblastic anemia
- Most common cause: pernicious anemia
  - Chronic autoimmune gastritis → parietal cell loss → ↓ IF
  - Autoantibodies: block B12 binding to IF or block IF-B12 uptake
  - T-cell mediated gastric injury initiates the process
- Other malabsorption causes: gastrectomy, ileal disease, ileal resection, achlorhydria

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🩸 Clinical Features

- Insidious onset → weakness, fatigue, pallor
- Gastrointestinal: glossitis, anorexia, diarrhea
- Neurologic:

    - Peripheral neuropathy (paresthesia, numbness, loss of vibration & position sense)
    - Subacute combined degeneration of the spinal cord (demyelination of dorsal columns & corticospinal tracts)
- Hematologic: macrocytic anemia, hypersegmented neutrophils, pancytopenia

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🧪 Diagnosis

1. Peripheral blood smear / bone marrow: megaloblastic changes
2. Serum B12 level: low
3. Additional tests:
    - Anti-intrinsic factor antibodies (pernicious anemia)
    - Methylmalonic acid ↑ and homocysteine ↑ (both sensitive for B12 deficiency)
4. Distinguishing from folate deficiency:

- Folate deficiency → no neurologic symptoms
- B12 deficiency → neurologic symptoms present

💡 Mnemonic for Vitamin B12 Deficiency Causes:

"GASTRIC B12"

- Gastritis (autoimmune, pernicious)
- Achalasia / atrophy of stomach
- Surgical removal (gastrectomy)
- Terminal ileum disease (Crohn, resection, Whipple)
- Restricted diet (vegan)
- Intrinsic factor deficiency
- Complementary malabsorption

-> The End <-