**Name**: **Thyroglobulin (Proloid)**

**Class**: Thyroid Hormone

**Mech**.: $T_3/T_4$ synergize w/GH effects, increase BMR, potentiate catecholamine effects on heart, promote lipolysis, and decrease serum cholesterol.

**Absorption**: Oral

**Dist**.: Poor placental transfer → okay for pregnant E. Little in milk (use cautiously).

**Metab**.: $T_4$ & $T_3$ released by proteolysis after ingestion. Hepatic conjug. of $T_4/T_3$ w/glucuronic & sulfuric acids.

**Excretion**, **t_**: Bile; some lost in stool due to enterohepatic circulation.

**Toxicity/S.E.s**: Salicylates and dicumarol compete for albumin binding sites → marked increase of free levels.

**Utility**: Treat hypothyroidism and goiter (not due to iodine deficiency or hyperthyroidism).

**Special Features**: 120-180 mg/d. Similar efficacy to levothyroxine sodium and liothyronine sodium, although dose not standardized by bioassay.

**Name**: **Levothyroxine sodium (Synthroid, Levothroid, Levoxine)**

**Class**: Thyroid Hormone

**Mech**.: Sodium salt of $T_4$. $T_3/T_4$ synergize w/GH effects, increase BMR, potentiate catecholamine effects on heart, promote lipolysis, and decrease serum cholesterol.

**Absorption**: Incomplete oral absorption—30-40% recovered in stool.

**Dist**.: Poor placental transfer → okay for pregnant E. Little in milk (use cautiously).

**Metab**.: Hepatic conjug. w/glucuronic & sulfuric acids. Peripheral deiodination to $T_3$.

**Excretion**, **t_**: Bile; some lost in stool due to enterohepatic circ. 6-7 d.

**Toxicity/S.E.s**: Salicylates and dicumarol compete for albumin binding sites → marked increase of free levels.

**Utility**: Treat hypothyroidism and goiter (not due to iodine deficiency or hyperthyroidism).

**Special Features**: 200-300 μg/d. 1/4 the potency of liothyronine sodium, but same efficacy.

**Name**: **Liothyronine sodium (Cytomel)**

**Class**: Thyroid Hormone

**Mech**.: Sodium salt of $T_3$. $T_3/T_4$ synergize w/GH effects, increase BMR, potentiate catecholamine effects on heart, promote lipolysis, and decrease serum cholesterol.

**Absorption**: Oral → 95% absorption.

**Dist**.: Poor placental transfer → okay for pregnant E. Little in milk (use cautiously).

**Metab**.: Hepatic conjug. w/glucuronic & sulfuric acids.

**Excretion**, **t_**: Bile; some lost in stool due to enterohepatic circ. ≤ 2 d.

**Toxicity/S.E.s**: Salicylates and dicumarol compete for albumin binding sites → marked increase of free levels.

**Utility**: Preferred in treatment of myxedema coma. Treat hypothyroidism and goiter (not due to iodine deficiency or hyperthyroidism).

**Special Features**: 50-75 μg/d. 4x the potency of levothyroxine sodium, but same efficacy.

**Name**: **Propylthiouracil (PTU)**

**Class**: Antithyroid Drug (Thioamide)

**Mech**.: Blocks thyroid synthesis.

**Absorption**: Oral → 80-95% bioavailability.

**Dist**.: 80% protein binding. Poor placental transfer. 10% transfer into milk.

**Metab**.: Conjugated to gluconamide.

**Excretion**, **t_**: 35% excreted in urine, mostly as gluconamide. 1-2 hr.

**Toxicity/S.E.s**: 3% freq. of untoward rxns. Most common = rash. 0.44% develop agranulocytosis. Occurs suddenly in first months of therapy, preceded by a sore throat and fever. Unusual bleeding and bruising may occur. C/i in nursing mothers, but can be used (w/great caution) in pregnancy-complicated hyperthyroidism (may cause neonatal goiter).

**Utility**: Treat hyperthyroidism, but relapse after single course ≥ 50%.

**Special Features**: 75-100 mg/8 hr (or higher).

**Name**: **Methimazole (Tapazole)**

**Class**: Antithyroid Drug (Thioamide)

**Mech**.: Blocks thyroid synthesis.

**Absorption**: Oral → 80-95% bioavailability.

**Dist**.: 0% protein binding. High placental transfer. 100% transfer into milk.

**Metab**.: Conjugated to gluconamide.

**Excretion**, **t_**: <10% excreted in urine, mostly as gluconamide. 3-5 hr.

**Toxicity/S.E.s**: 7% freq. of untoward rxns. Most common = rash. 0.12% develop agranulocytosis. Occurs suddenly in first months of therapy, preceded by a sore throat and fever. Unusual bleeding and bruising may occur. C/i in nursing mothers, but can be used (w/great caution) in pregnancy-complicated hyperthyroidism (may cause neonatal goiter); PTU is safer.

**Utility**: Treat hyperthyroidism, but relapse after single course ≥ 50%.

**Special Features**: 5-10 mg/8 hr (or higher).

**Name**: **Iodide**

**Class**: Antithyroid drug

**Mech**.: High doses of iodide inhibit thyroid gland fxn. Effects decrease w/time, possible due to decrease in iodide transport.

**Absorption**:

**Dist**.:

**Metab**.:

**Excretion**, **t_**:

**Toxicity/S.E.s**:

**Utility**: Used in conjunction w/thioamides for preoperative preparation to diminish vascularity and swelling of thyroid gland → reduced operative mortality. Treatment of thyrotoxicosis. Blocks synthesis and release of thyroid hormones. Rapid effect.

**Special Features**: No longer used very much.

**Name**: **Radioactive Iodine**

**Class**: Antithyroid Drug

**Mech**.: Trapped by thyroid. β particles cause highly localized tissue destruction. X-rays are diagnostically useful. $I^{131}$ generally used due to short t_ (8 d).

**Absorption**: 90% ends up in thyroid or urine. 10% absorbed by the rest of the organ systems.

**Dist**.: **Metab**.:

**Excretion**, **t_**: Urine. 8 d.

**Toxicity/S.E.s**: High incidence of hypothyroidism (5-10% in 1-2 yr., eventually 50%). May require multiple exposures—up to a year (thioamides usu. used to cover hyperthyroidism in the interim). C/i in pregnant E and kids.

**Utility**: Treat hyperthyroidism w/o surgery. Indicated for old folk (esp. w/heart disease), when subtotal thyroidectomy or thioamides have not worked, and especially for some metastatic thyroid cancers where cells continue to take up iodide and respond to TSH. Used to evaluate thyroid fxn (e.g., hypo/hyperthyroidism, goiter types, response to TSH/TRF.).

**Special Features**: Min. dose = 80-150 μCi/g thyroid or 4-10 mCi total. Estimate w/tracer dose to determine uptake.

**Name**: **Propranolol (Inderal)**

**Class**: Nonselective β-Blocking Agent

**Mech**.: Competitive blockade of β1 and β2 receptors. No α effect. Decreases conversion of $T_4$ to $T_3$ by inhibiting hepatic monodeiodinase.

**Absorption**: Good oral (>90%). But low bioavailability ~30%. Plasma levels vary 20x btwn. patients.

**Dist**.:93% bound to protein. Enters CNS. **Metab**.: Hepatic **Excret.**, **t_**: Short t_ (3.5-6 hr).

**Toxicity/S.E.s**: **CV**—hypotension, bradycardia, c/i for CHF or AV block. **Resp**—c/i in asthmatics, COPD, bronchitis, allergic rhinitis. **Metab**—caution w/diabetics (masks sign of hypoglycemia: tachycardia). **CNS**—weakness, fatigue, nightmares, depression. **GI**—n/v (uncommon). **Hypersens**—rash, hematologic disorders (rare).

**Utility**: Hypertension (↓ CO → ↓ BP; blocks renin release). Angina pectoris (prophylactic → ↑ exercise tolerance due to ↓ $O_2$ demand). Cardiac arrhythmias (esp. supravent. tachyarrhyths). Acute MI (prophylaxis and reduction of infarct size and failure). Pheochromocytoma (in comb. w/alpha blocker). Essential tremor. Migraine headache (prophylaxis). Performance anxiety. Thyrotoxicosis—Suppression of signs/symptoms of thyrotoxicosis. Most effective drug for treatment of thyrotoxic crisis or thyroid storm (usu. used in comb w/a thioamide and/or iodide. Can be used preop. for thyroid surg. Controversial Rx of hyperthyroid symptoms while awaiting effects of thioamides or iodide.

**Special Features**: Abrupt w/drawal may trigger MI.

**Name**: **Calcium gluconate (Kalcinate)**
**Class**: Element
**Mech**.:
**Absorption**: Slow IV infusion.
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Major = hypercalcemia (esp. during long-term therapy or co-admin. w/vit. D). Hypercalciuria. Rapid infusion may cause cardiac arrhythmias. Enhances action of digitalis. ∴ IV infusion may ppt arrhythmias. Drug interactions—↓ bioavailability and/or oral absorption of some drugs (e.g., etidronate, tetracyclines, iron salts, atenolol, norfloxacin). Thiazide diuretic-induced hypercalcemias exacerbated by calcium supplementation.
**Utility**: DOC for severe hypocalcemia. Reduces/prevents bone loss in older women (800 mg/d).
**Special Features**: 9% calcium.

**Name**: **Calcium gluceptate**
**Class**: Element
**Mech**.:
**Absorption**: IV (IM if IV is infeasible).
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Major = hypercalcemia (esp. during long-term therapy or co-admin. w/vit. D). Hypercalciuria. More irritating than calcium gluconate. May cause mild local rxns (e.g., tingling). Metallic taste. Enhances action of digitalis. ∴ IV infusion may ppt arrhythmias. Drug interactions—↓ bioavailability and/or oral absorption of some drugs (e.g., etidronate, tetracyclines, iron salts, atenolol, norfloxacin). Thiazide diuretic-induced hypercalcemias exacerbated by calcium supplementation.
**Utility**: Treat hypocalcemia. Reduces/prevents bone loss in older women (800 mg/d).
**Special Features**: 8% calcium.

**Name**: **Calcium chloride**
**Class**: Element
**Mech**.:
**Absorption**: IV. Never inject IM (highly irritating).
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Major = hypercalcemia (esp. during long-term therapy or co-admin. w/vit. D). Hypercalciuria. Enhances action of digitalis. ∴ IV infusion may ppt arrhythmias. High level of irritation (esp. IM). Drug interactions—↓ bioavailability and/or oral absorption of some drugs (e.g., etidronate, tetracyclines, iron salts, atenolol, norfloxacin). Thiazide diuretic-induced hypercalcemias exacerbated by calcium supplementation.
**Utility**: Treat hypocalcemia. Reduces/prevents bone loss in older women (800 mg/d).
**Special Features**: 27% calcium. Probably obsolete due to greater irritation (enteral or parenteral admin.) than other calcium preparations.

**Name**: **Calcium carbonate (TUMS, etc.)**
**Class**: Element
**Mech**.:
**Absorption**: Oral usu. → 15-20% (up to 50% w/maximal stimulation). Depends of stomach acid for solubilization. ∴ Absorption is impaired in anchlorhydric or fasting patients. Absorption improved when taken w/food.
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Hypercalcemia, hypercalciuria. Drug interactions—↓ bioavailability and/or oral absorption of some drugs (e.g., etidronate, tetracyclines, iron salts, atenolol, norfloxacin). Thiazide diuretic-induced hypercalcemias exacerbated by calcium supplementation.
**Utility**: Treat mild hypocalcemia. Also maintenance after initial IV treatment. Provide 400-800 mg/d. Reduces/prevents bone loss in older women (800 mg/d).
**Special Features**: 40% calcium.

**Name**: **Calcium citrate (Citracal, etc.)**
**Class**: Element
**Mech**.:
**Absorption**: Oral usu. → 15-20% (up to 50% w/maximal stimulation).
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Hypercalcemia, hypercalciuria. Drug interactions—↓ bioavailability and/or oral absorption of some drugs (e.g., etidronate, tetracyclines, iron salts, atenolol, norfloxacin). Thiazide diuretic-induced hypercalcemias exacerbated by calcium supplementation.
**Utility**: Treat mild hypocalcemia. Also maintenance after initial IV treatment. Provide 400-800 mg/d. Reduces/prevents bone loss in older women (800 mg/d).
**Special Features**: 21% calcium. More soluble than calcium carbonate. Works better in anchlorhydrics.

**Name**: **Calcium glubionate (Neo-Calglucon)**
**Class**: Element
**Mech**.:
**Absorption**: Oral usu. → 15-20% (up to 50% w/maximal stimulation).
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Hypercalcemia, hypercalciuria, diarrhea. Drug interactions—↓ bioavailability and/or oral absorption of some drugs (e.g., etidronate, tetracyclines, iron salts, atenolol, norfloxacin). Thiazide diuretic-induced hypercalcemias exacerbated by calcium supplementation.
**Utility**: Treat mild hypocalcemia. Also maintenance after initial IV treatment. Provide 400-800 mg/d. Reduces/prevents bone loss in older women (800 mg/d).
**Special Features**: 6.5% calcium. Probably obsolete due to large number of tablets necessary to obtain effect.

**Name**: **Calcium lactate**
**Class**: Element
**Mech**.:
**Absorption**: Oral usu. → 15-20% (up to 50% w/maximal stimulation).
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Hypercalcemia, hypercalciuria. Drug interactions—↓ bioavailability and/or oral absorption of some drugs (e.g., etidronate, tetracyclines, iron salts, atenolol, norfloxacin). Thiazide diuretic-induced hypercalcemias exacerbated by calcium supplementation.
**Utility**: Treat mild hypocalcemia. Also maintenance after initial IV treatment. Provide 400-800 mg/d. Reduces/prevents bone loss in older women (800 mg/d).
**Special Features**: 13% calcium. Probably obsolete due to large number of tablets necessary to obtain effect.

**Name**: **Tribasic calcium phosphate**
**Class**: Element
**Mech**.:
**Absorption**: Oral.
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Ectopic calcification, kidney failure, death. Serum calcium and phosphate should be monitored to avoid hypocalcemia and hyperphosphatemia.
**Utility**: Treat simultaneous hypocalcemia and hypophosphatemia.
**Special Features**: 39% tribasic calcium phosphate.

**Name**: **Dicalcium phosphate**
**Class**: Element
**Mech**.:
**Absorption**: Oral.
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Ectopic calcification, kidney failure, death. Serum calcium and phosphate should be monitored to avoid hypocalcemia and hyperphosphatemia.
**Utility**: Treat simultaneous hypocalcemia and hypophosphatemia.
**Special Features**: 23% dibasic calcium phosphate dihydrate.

**Name**: **Sodium phosphate oral solution**
**Class**: Element
**Mech**.:
**Absorption**: Oral
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Ectopic calcification, kidney failure, death. Serum calcium and phosphate should be monitored to avoid hypocalcemia and hyperphosphatemia.
**Utility**: Primarily reserved for patients w/X-linked familial hypophosphatemia or other forms of osteomalacia featuring hypophosphatemia.
**Special Features**: Safer than IV sodium/potassium phosphate. Sodium-free preparations are available (**K-Phos Original**, **Neutra-Phos K**).

**Name**: **Sodium or potassium phosphate**
**Class**: Element
**Mech**.:
**Absorption**: IV
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Ectopic calcification, kidney failure, death. Serum calcium and phosphate should be monitored to avoid hypocalcemia and hyperphosphatemia.
**Utility**: Treat hypophosphatemia.
**Special Features**: More dangerous than sodium phosphate oral solution.

**Name**: **Vitamin $D_2$/ergocalciferol (Deltalin, Drisdol, Calciferol)**
**Class**: Vitamin
**Mech**.: Increases intestinal absorption of calcium and phosphate. Stimulates bone resorption by facilitating effects of PTH. Stimulates renal reabsorption of calcium and phosphate. Net result = ↑↑ calcium, ↑↑ phosphate.
**Absorption**: Oral usu → adequate absorption. Bile is essential for absorption.
**Dist**.: Stored in fat and muscle. Tightly bound to vitamin D-binding protein.
**Metab**.: Requires hydroxylation in liver and kidney for full activity.
**Excretion**, **t_**: 1° = bile. Weeks.
**Toxicity/S.E.s**: Excess accumulation in fat/muscle, hypervitaminosis D, hypercalcemia. Drug interactions—phenytoin and phenobarbital reduce sensitivity to vit. D and/or increase rate of inactivation of calcitriol.
**Utility**: Treat nutritional rickets; prophylactic dose = 400 U/d, fully developed rickets = 3,000-4,000 U/d. Ameliorates Type I vit. D-dependent rickets (4,000 U/d). Supplement to estrogen and calcium to treat postmenopausal osteoporosis. Treat hypoparathyroidism (25-100,000 U 3x/wk + oral calcium); use calcitriol or dihydrotachysterol for faster action or if hypervit.

**Name**: **Vitamin $D_3$/cholecalciferol (Delta-D)**
**Class**: Vitamin
**Mech**.: Increases intestinal absorption of calcium and phosphate. Stimulates bone resorption by facilitating effects of PTH. Stimulates renal reabsorption of calcium and phosphate. Net result = ↑↑ calcium, ↑↑ phosphate.
**Absorption**: Oral usu → adequate absorption. Bile is essential for absorption.
**Dist**.: Stored in fat and muscle. Tightly bound to vitamin D-binding protein.
**Metab**.: Requires hydroxylation in liver and kidney for full activity.
**Excretion**, **t_**: 1° = bile. Weeks.
**Toxicity/S.E.s**: Excess accumulation in fat/muscle, hypervitaminosis D, hypercalcemia. Drug interactions—phenytoin and phenobarbital reduce sensitivity to vit. D and/or increase rate of inactivation of calcitriol.
**Utility**: Treat nutritional rickets—prophylactic dose = 400 U/d, fully developed rickets = 3,000-4,000 U/d. Ameliorates Type I vit. D-dependent rickets (4,000 U/d). Treat osteodystrophy 2° to malabsorption of vit. D and calcium—25-50,000 U 3x/wk + calcium. Supplement to estrogen and calcium to treat postmenopausal osteoporosis. Treat hypoparathyroidism (25-100,000 U 3x/wk + oral calcium); use calcitriol or dihydrotachysterol for faster action or if hypervit. D develops.
**Special Features**:

**Name**: **Calcifediol/25-OH-cholecalciferol**
**Class**: Vitamin
**Mech**.: Increases intestinal absorption of calcium and phosphate. Stimulates bone resorption by facilitating effects of PTH. Stimulates renal reabsorption of calcium and phosphate. Net result = ↑↑ calcium, ↑↑ phosphate.
**Absorption**: Oral usu → adequate absorption. Bile is essential for absorption.
**Dist**.: Stored in fat and muscle. Tightly bound to vitamin D-binding protein.
**Metab**.: Requires hydroxylation in kidney for full activity.
**Excretion**, **t_**: 1° = bile. Weeks.
**Toxicity/S.E.s**: Excess accumulation in fat/muscle, hypervitaminosis D, hypercalcemia. Drug interactions—phenytoin and phenobarbital reduce sensitivity to vit. D and/or increase rate of inactivation of calcitriol.
**Utility**: Treat osteomalacia 2° to liver disease. Treat renal osteodystrophy 2° to chronic renal disease—50-100 μg/d (larger dose necessary because kidney hydroxylation is deficient).
**Special Features**: Does not require liver activation. Fully activated in kidney. More effective than calcitriol for increasing renal absorption of calcium and phosphate. Much less effective than calcitriol for increasing bone resorption and increasing intestinal reabsorption of calcium and phosphate.

**Name**: **Calcitriol/1,25-$(OH)_2$-cholecalciferol (Rocaltrol)**
**Class**: Vitamin
**Mech**.: Increases intestinal absorption of calcium and phosphate. Stimulates bone resorption by facilitating effects of PTH. Stimulates renal reabsorption of calcium and phosphate. Net result = ↑↑ calcium, ↑↑ phosphate.
**Absorpt.**: Oral usu → adequate absorption. Bile essential for absorpt. Parenteral.
**Dist**.: Stored in fat and muscle. Tightly bound to vitamin D-binding protein.
**Metab**.:
**Excretion**, **t_**: 1° = bile. Hours.
**Toxicity/S.E.s**: Excess accumulation in fat/muscle, hypervitaminosis D, hypercalcemia. Drug interactions—phenytoin and phenobarbital reduce sensitivity to vit. D and/or increase rate of inactivation of calcitriol.
**Utility**: Vit. D metab. of choice for rapid action. Raises serum calcium in 1-2 d. Treat X-linked hypophosphatemic rickets (0.25-1 μg/d + phosphate salts). Treat renal osteodystrophy 2° to chronic renal disease. Ameliorates Type I vit. D-dependent rickets (0.25-0.5 μg/d). Treat hypoparathyroidism (+

**Name**: **Dihydrotachysterol (Hytakerol, DHT)**
**Class**: Vitamin
**Mech**.: Increases intestinal absorption of calcium and phosphate. Stimulates bone resorption by facilitating effects of PTH. Stimulates renal reabsorption of calcium and phosphate. Net result = ↑↑ calcium, ↑↑ phosphate.
**Absorption**: Oral usu → adequate absorption. Bile is essential for absorption.
**Dist**.: Stored in fat and muscle. Tightly bound to vitamin D-binding protein.
**Metab**.: Requires hydroxylation in liver for full activity.
**Excretion**, **t_**: 1° = bile.
**Toxicity/S.E.s**: Excess accumulation in fat/muscle, hypervitaminosis D, hypercalcemia. Drug interactions—phenytoin and phenobarbital reduce sensitivity to vit. D and/or increase rate of inactivation of calcitriol.
**Utility**: Treat X-linked hypophosphatemic rickets (+ phosphate salts). Treat renal osteodystrophy 2° to chronic renal disease. Treat hypoparathyroidism (+ calcium).
**Special Features**: Does not require kidney activation. Liver hydroxylation produces full activity. _ the price of calcitriol, but takes 1-2 wk. to increase serum calcium. Serum concentration not measurable.

**Name**: **Synthetic parathyroid hormone (Teriparatide, Parathar)**

**Class**: Hormone

**Mech**.: Mobilizes bone calcium by stimulating bone resorption. Increases renal absorption of calcium. Decreases renal absorption of phosphate. Increases synth. of calcitriol → ↑intest. absorption of calcium and phosphate. Net result = ↑↑calcium, ↓↓phosphate.

**Absorption**: **Dist**.: **Metab**.: Inactivated by proteolysis.

**Excretion**, **t_**: Minutes.

**Toxicity/S.E.s**:

**Utility**: Only used for differential diagnosis—hypoparathyroidism vs. pseudohypoparathyroidism. There is less of an increase in urinary cAMP and phosphate in pseudohypoparathyroidism.

**Special Features**: Consists of active portion of PTH (1st 34 AAs on N-terminal). **Not** used to treat hypoparathyroidism. Currently being investigated for treatment of osteoporosis. Intermittent therapy → anabolic effects on bone.

**Name**: **Human calcitonin (Cibacalcin, Calcimar)**

**Class**: Hormone

**Mech**.: Inhibition of both bone resorption and renal tubular reabsorption of calcium and phosphate. Secretion stim by ↑ serum calcium. Net result = ↓↓calcium, ↓↓phosphate.

**Absorption**: SC, IM. Nasal is variable and often poor.

**Dist**.:

**Metab**.: Inactivated by proteolysis in kidneys and blood.

**Excretion**, **t_**: Minutes.

**Toxicity/S.E.s**: Flushing of face and hands w/in min. of injxn (16-21%). Nausea/vomiting w/in 30 min. of use (14-21%); usu. diminishes w/continued therapy. Bedtime admin. can minimize effects. Urinary frequency (5-10%)

**Utility**: Initial treatment of hypercalcemia. Diseases characterized by increased skeletal remodeling (e.g., Paget's disease of bone). Recently approved for treatment of postmenopausal osteoporosis.

**Special Features**: Effects begin after several hours, persist for up to 10 hr. Salmon calcitonin has a longer t_ and duration and is 50x more potent. However, 30-50% of long-term patients develop antibodies to salmon calcitonin.

**Name**: **Sodium etidronate (Didronel)**

**Class**: Bisphosphonate

**Mech**.: Structure sim. to inorganic pyrophosphate. Impairs formation and dissolution of calcium phosphate crystals. Alters number/activity of osteoclasts (1° effect) → slowed bone resorption. Slows formation and dissolution of hydroxyapatite crystals.

**Absorp**.: Oral → very little absorp., but still effective. Oral absorp. varies w/dose. Further reduced by food or divalent cations. IV → much higher blood levels.

**Dist**.: 50% of absorbed drug accum. in bone and turns over w/t_ of weeks.

**Metab**.:

**Excretion**, **t_**: 50% rapidly excreted unchanged by kidney.

**Toxicity/S.E.s**: Protracted or high-dose therapy → osteomalacia.

**Utility**: Treat Paget's disease of bone as well as or better than calcitonin—oral efficacy, lower cost, no antigenicity, longer remissions. However, chronic use → osteomalacia w/↑risk of bone pain & fractures. Treat heterotopic ossification—given orally after total hip replacement or spinal injury. Treat hypercalcemia of malignancy (IV). Under testing for long-term intermittent therapy for vertebral osteoporosis (+ calcium and vit. D).

**Special Features**: Unlike pyrophosphate, resistant to enzymatic hydrolysis. Clinical failure of therapy often due to coadmin. w/calcium tablets or food.

**Name**: **Pamidronate (Aredia)**

**Class**: Bisphosphonate

**Mech**.: Structure sim. to inorganic pyrophosphate. Impairs formation and dissolution of calcium phosphate crystals. Alters number/activity of osteoclasts (1° effect) → slowed bone resorption. Slows formation and dissolution of hydroxyapatite crystals.

**Absorption**: IV admin. only

**Dist**.:

**Metab**.:

**Excretion**, **t_**:

**Toxicity/S.E.s**:

**Utility**: DOC for mod.-severe hypercalcemia assoc. w/malignant neoplasms. Treat Paget's disease of bone. Must be used in conjnxn w/adequate hydration and urinary output.

**Special Features**: 100x more potent than etidronate, more efficacious, and does not affect normal bone mineralization at normal therapeutic concentrations.

**Name**: **Alendronate (Fosamax)**

**Class**: Bisphosphonate

**Mech**.: Structure sim. to inorganic pyrophosphate. Impairs formation and dissolution of calcium phosphate crystals. Alters number/activity of osteoclasts (1° effect) → slowed bone resorption. Slows formation and dissolution of hydroxyapatite crystals.

**Absorption**:

**Dist**.:

**Metab**.:

**Excretion**, **t_**:

**Toxicity/S.E.s**:

**Utility**: Increases bone mass in spines and hips of postmenopausal women → ↓ incidence of fractures.

**Special Features**: Efficacy maintained over at least 3 yr.

**Name**: **Prednisone**
**Class**: Corticosteroid (Glucocorticoid)
**Mech**.: ↑ PMNs in periph. blood, but decrease all other WBCs. Inhib. monocyte reactivity and secretion of IL-1 & TNF. Inhib. T cell activation, IgE-med. rxns, inducible cyclooxygenase II expression. Induces lipocortin → inhibition of phospholipase A2.
**Absorption**: IV, IM, oral.
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Cataracts, hypertension, osteoporosis, myopathy, obesity, acne, hirsutism, hyperglycemia, muscle atrophy/myopathy, convulsions, mood changes, derm. changes, ↓ cellular immunity. Glucocorticoid admin > equiv. of 20 mg hydrocortisone/d → suppression of HPA axis. Sudden stop of chronic therapy → impaired physiologic homeostasis. Drug Interactions—phenytoin, barbiturates, & rifampin induce catabolic enzymes; antacids → ↓ bioavailability of prednisone; salicylate levels reduced; increased doses required for insulin, hypoglycemic agents, antihypertensives, and glaucoma meds; if hypokalemia occurs, increased toxicity of digoxin.
**Utility**: Oral for asthma. Immunosuppression, anti-inflammatory actions, cytostatic actions against some lymphocyte tumors, mgt. of allergic diseases.
**Special Features**: Synth. agents have potent anti-inflamm. activity w/little (if any) mineralocorticoid effect.

**Name**: **Plicamycin (Mithracin, nee Mithramycin)**
**Class**: Antibiotic (Cytotoxic)
**Mech**.: Intercalates into DNA like actinomycin and blocks DNA, RNA, and protein synthesis. Supposedly decreases serum calcium levels by direct toxic action on osteoclasts.
**Absorption**:
**Dist**.:
**Metab**.:
**Excretion**, **t_**:
**Toxicity/S.E.s**: Less severe w/doses for hypercalcemia than for neoplasms. Sudden onset of thrombocytopenia followed by hemorrhage. Hepatic and renal toxicity. Hypocalcemia. Monitor platelet count, liver/kidney fxn, and serum calcium. C/i for patients w/renal or hepatic disease, bone marrow disease, thrombocytopathy, coagulation disorders, or bleeding susceptibilities of other etiologies.
**Utility**: Treat severe hypercalcemia resulting from CA w/wo bony metastases. Treat testicular neoplasms.
**Special Features**: Use limited by toxicity.

**Name**: **Hydrocortisone/Cortisol**

**Class**: Corticosteroid (Glucocorticoid)

**Mech**.: ↑ PMNs in periph. blood, but decrease all other WBCs. Inhib. monocyte reactivity and secretion of IL-1 & TNF. Inhib. T cell activation, IgE-med. rxns, inducible cyclooxygenase II expression. Induces lipocortin → inhibition of phospholipase A2.

**Absorption**: IV, IM, oral, topical.

**Dist**.: **Metab**.: **Excretion**, **t_**: 8-12 hr.

**Toxicity/S.E.s**: Cataracts, hypertension, osteoporosis, myopathy, obesity, acne, hirsutism, hyperglycemia, muscle atrophy/myopathy, convulsions, mood changes, derm. changes, ↓ cellular immunity. Glucocorticoid admin > equiv. of 20 mg hydrocortisone/d → suppression of HPA axis. Sudden stop of chronic therapy → impaired physiologic homeostasis. Drug Interactions—phenytoin, barbiturates, & rifampin induce catabolic enzymes; antacids → ↓ bioavailability of prednisone; salicylate levels reduced; increased doses required for insulin, hypoglycemic agents, antihypertensives, and glaucoma meds; if hypokalemia occurs, increased toxicity of digoxin.

**Utility**: IV/IM for asthma. Immunosuppression, anti-inflammatory actions, cytostatic actions against some lymphocyte tumors, mgt. of allergic diseases.

**Special Features**: Rel. anti-inflamm potency = 1. Synth. agents have potent anti-inflamm. activity w/little (if any) mineralocorticoid effect.

**Name**: **Beclomethasone diproprionate (Beclovent)**

**Class**: Corticosteroid (Glucocorticoid)

**Mech**.: ↑ PMNs in periph. blood, but decrease all other WBCs. Inhib. monocyte reactivity and secretion of IL-1 & TNF. Inhib. T cell activation, IgE-med. rxns, inducible cyclooxygenase II expression. Induces lipocortin → inhibition of phospholipase A2.

**Absorption**: Aerosol, nasal pump spray, oral, topical.

**Dist**.: **Metab**.: **Excretion**, **t_**:

**Toxicity/S.E.s**: Cataracts, hypertension, osteoporosis, myopathy, obesity, acne, hirsutism, hyperglycemia, muscle atrophy/myopathy, convulsions, mood changes, derm. changes, ↓ cellular immunity. Glucocorticoid admin > equiv. of 20 mg hydrocortisone/d → suppression of HPA axis. Sudden stop of chronic therapy → impaired physiologic homeostasis. Drug Interactions—phenytoin, barbiturates, & rifampin induce catabolic enzymes; antacids → ↓ bioavailability of prednisone; salicylate levels reduced; increased doses required for insulin, hypoglycemic agents, antihypertensives, and glaucoma meds; if hypokalemia occurs, increased toxicity of digoxin. Aerosol—oral candidiasis, dysphonia.

**Utility**: Asthma, allergic rhinitis. Immunosuppression, anti-inflammatory actions, cytostatic actions against some lymphocyte tumors, mgt. of allergic diseases.

**Special Features**: Synth. agents have potent anti-inflamm. activity w/little (if any) mineralocorticoid effect.

**Name**: **Triamcinolone acetonide (Azmacort)**

**Class**: Corticosteroid (Glucocorticoid)

**Mech**.: ↑ PMNs in periph. blood, but decrease all other WBCs. Inhib. monocyte reactivity and secretion of IL-1 & TNF. Inhib. T cell activation, IgE-med. rxns, inducible cyclooxygenase II expression. Induces lipocortin → inhibition of phospholipase A2.

**Absorption**: IM, aerosol, oral, topical, intraarticular.

**Dist**.: **Metab**.: **Excretion**, **t_**: 12-36 hr.

**Toxicity/S.E.s**: Cataracts, hypertension, osteoporosis, myopathy, obesity, acne, hirsutism, hyperglycemia, muscle atrophy/myopathy, convulsions, mood changes, derm. changes, ↓ cellular immunity. Glucocorticoid admin > equiv. of 20 mg hydrocortisone/d → suppression of HPA axis. Sudden stop of chronic therapy → impaired physiologic homeostasis. Drug Interactions—phenytoin, barbiturates, & rifampin induce catabolic enzymes; antacids → ↓ bioavailability of prednisone; salicylate levels reduced; increased doses required for insulin, hypoglycemic agents, antihypertensives, and glaucoma meds; if hypokalemia occurs, increased toxicity of digoxin. Aerosol—oral candidiasis, dysphonia.

**Utility**: Asthma. Intraarticular injxn. to reduce inflamm. Immunosuppression, anti-inflammatory actions, cytostatic actions against some lymphocyte tumors, mgt. of allergic diseases.

**Special Features**: Rel. anti-inflamm. potency of 5. Synth. agents have potent anti-inflamm. activity w/little (if any) mineralocorticoid effect.

**Name**: **Dexamethasone (Decadron)**

**Class**: Corticosteroid (Glucocorticoid)

**Mech**.: ↑ PMNs in periph. blood, but decrease all other WBCs. Inhib. monocyte reactivity and secretion of IL-1 & TNF. Inhib. T cell activation, IgE-med. rxns, inducible cyclooxygenase II expression. Induces lipocortin → inhibition of phospholipase A2.

**Absorption**: IV, IM, Oral, topical, intraarticular.

**Dist**.: **Metab**.: **Excretion**, **t_**: 36-72 hr.

**Toxicity/S.E.s**: Cataracts, hypertension, osteoporosis, myopathy, obesity, acne, hirsutism, hyperglycemia, muscle atrophy/myopathy, convulsions, mood changes, derm. changes, ↓ cellular immunity. Glucocorticoid admin > equiv. of 20 mg hydrocortisone/d → suppression of HPA axis. Sudden stop of chronic therapy → impaired physiologic homeostasis. Drug Interactions—phenytoin, barbiturates, & rifampin induce catabolic enzymes; antacids → ↓ bioavailability of prednisone; salicylate levels reduced; increased doses required for insulin, hypoglycemic agents, antihypertensives, and glaucoma meds; if hypokalemia occurs, increased toxicity of digoxin.

**Utility**: Intraarticular injxn. to reduce inflamm. Immunosuppression, anti-inflammatory actions, cytostatic actions against some lymphocyte tumors, mgt. of allergic diseases.

**Special Features**: Rel. anti-inflamm. potency of 20-30. Synth. agents have potent anti-inflamm. activity w/little (if any) mineralocorticoid effect.

**Name**: **Regular insulin**

**Class**: Insulin (Fast-Acting Insulin Injection)

**Mech**.: Interacts w/ insulin receptors on cell membranes → phosph/dephosph of enzymes→ glucose transport into cells (esp. fat & muscle), glycogen synth., ↓ FFA, ↑ triglyceride storage, $K^+$ & $Mg^{2+}$ uptake, protein synth. Regulation of cell proliferation & differentiation. May activate cAMP (significance unknown).

**Absorption**: Injection (usu. SC).

**Dist**.:

**Metab**.: Rapidly metab. by liver, kidneys, and muscle.

**Excretion**, **t_**: 5-6 min.

**Toxicity/S.E.s**: Most freq. = hypoglycemia → ANS hyperactivity, impaired CNS fxn (confusion, bizarre behavior, coma). Skin rxns—transient urticaria, subcut. fibrosis, localized atrophy of subcut. tissue. Allergic rxn. Insulin resistance—refractory receptors or anti-insulin antibodies (may require 200-1000 units/d).

**Utility**: Treat diabetes mellitus. Preprandial control of blood glucose.

**Special Features**: Rapid onset (0.5-1 hr). Short duration (5-8 hr). Amorphous.

**Name**: **Isophane insulin suspension (NPH insulin)**
**Class**: Insulin (Intermediate-Acting Suspension)
**Mech**.: Interacts w/ insulin receptors on cell membranes → phosph/dephosph of enzymes → glucose transport into cells (esp. fat & muscle), glycogen synth., ↓ FFA, ↑ triglyceride storage, $K^+$ & $Mg^{2+}$ uptake, protein synth. Regulation of cell proliferation & differentiation. May activate cAMP (significance unknown).
**Absorption**: Injection (usu. SC).
**Dist**.:
**Metab**.: Rapidly metab. by liver, kidneys, and muscle.
**Excretion**, **t_**: 5-6 min.
**Toxicity/S.E.s**: Most freq. = hypoglycemia → ANS hyperactivity, impaired CNS fxn (confusion, bizarre behavior, coma). Skin rxns—transient urticaria, subcut. fibrosis, localized atrophy of subcut. tissue. Allergic rxn. Insulin resistance—refractory receptors or anti-insulin antibodies (may require 200-1000 units/d).
**Utility**: Treat diabetes mellitus. Basal control of blood glucose.

**Name**: **Insulin Zn (Lente insulin)**
**Class**: Insulin (Intermediate-Acting Suspension)
**Mech**.: Interacts w/ insulin receptors on cell membranes → phosph/dephosph of enzymes → glucose transport into cells (esp. fat & muscle), glycogen synth., ↓ FFA, ↑ triglyceride storage, $K^+$ & $Mg^{2+}$ uptake, protein synth. Regulation of cell proliferation & differentiation. May activate cAMP (significance unknown).
**Absorption**: Injection (usu. SC).
**Metab**.: Rapidly metab. by liver, kidneys, and muscle.
**Excretion**, **t_**: 5-6 min.
**Toxicity/S.E.s**: Most freq. = hypoglycemia → ANS hyperactivity, impaired CNS fxn (confusion, bizarre behavior, coma). Skin rxns—transient urticaria, subcut. fibrosis, localized atrophy of subcut. tissue. Allergic rxn. Insulin resistance—refractory receptors or anti-insulin antibodies (may require 200-1000 units/d).
**Utility**: Treat diabetes mellitus. Basal control of blood glucose.
**Special Features**: 70% crystalline form (ultralente) + 30% amorphous form

**Name**: **Extended insulin zinc suspension (Ultralente insulin)**
**Class**: Insulin (Long-Acting)
**Mech**.: Interacts w/ insulin receptors on cell membranes → phosph/dephosph of enzymes → glucose transport into cells (esp. fat & muscle), glycogen synth., ↓ FFA, ↑ triglyceride storage, $K^+$ & $Mg^{2+}$ uptake, protein synth. Regulation of cell proliferation & differentiation. May activate cAMP (significance unknown).
**Absorption**: Injection (usu. SC).
**Metab**.: Rapidly metab. by liver, kidneys, and muscle.
**Excretion**, **t_**: 5-6 min.
**Toxicity/S.E.s**: Most freq. = hypoglycemia → ANS hyperactivity, impaired CNS fxn (confusion, bizarre behavior, coma). Skin rxns—transient urticaria, subcut. fibrosis, localized atrophy of subcut. tissue. Allergic rxn. Insulin resistance—refractory receptors or anti-insulin antibodies (may require 200-1000 units/d).
**Utility**: Treat diabetes mellitus. Basal control of blood glucose.

**Name**: **Tolbutamide (Orinase)**
**Class**: Anti-Diabetes Agent (Oral Hypoglycemic) (Sulfonylurea) (First Generation)
**Mech**.: Interferes w/ATP-sensitive $K^+$ channel. Reduced $K^+$ conductance → depolarization & influx of $Ca^{2+}$. Stim. of insulin release from pancreas, ↓ glucagon, ↑ binding of insulin to target tissue receptors.
**Absorption**: Oral.
**Dist**.: Largely bound to plasma proteins.
**Metab**.: Hepatic.
**Excretion**, **t_**: Short duration of action (~8 hr).
**Toxicity/S.E.s**: Severe side effects in 2-4%. Only 10% still use them after 6-9 yrs of treatment. Sustained hypoglycemia up to 4-5 days after discontinued use. Rash (rare), GI upset (3-4%), hematological disturbance—usu. leukopenia (1%), inappropriate ADH release (→ hyponatremia), flushing, disulfiram action, variability in steady state conc. Drug interactions—protein binding (alcohol, β blockers, MAO inhibitors).
**Utility**: NIDDM—prevents acute hyperglycemic problems, may postpone development of glucose intolerance, may delay thickening of capillary BM.
**Special Features**:

**Name**: **Chlorpropramide (Diabinese)**
**Class**: Anti-Diabetes Agent (Oral Hypoglycemic) (Sulfonylurea) (First Generation)
**Mech**.: Interferes w/ATP-sensitive $K^+$ channel. Reduced $K^+$ conductance → depolarization & influx of $Ca^{2+}$. Stim. of insulin release from pancreas, ↓ glucagon, ↑ binding of insulin to target tissue receptors.
**Absorption**: Oral.
**Dist**.: Largely bound to plasma proteins.
**Metab**.: Hepatic.
**Excretion**, **t_**: Long duration of action (36+ hr).
**Toxicity/S.E.s**: Severe side effects in 2-4%. Only 10% still use them after 6-9 yrs of treatment. Sustained hypoglycemia (esp. likely) up to 4-5 days after discont. use. Rash (rare), GI upset (3-4%), hematological disturbance—usu. leukopenia (1%), inappropriate ADH release (→ hyponatremia), flushing, disulfiram action (highest incidence of the class), variability in steady state conc. C/i in the elderly. Drug interactions—protein binding (alcohol, β blockers, MAO inhibitors).
**Utility**: NIDDM—prevents acute hyperglycemic problems, may postpone development of glucose intolerance, may delay thickening of capillary BM.
**Special Features**: Highest incidence of S.E.'s in sulfonylurea group.

**Name**: **Glyburide (Micronase)**
**Class**: Anti-Diabetes Agent (Oral Hypoglycemic) (Sulfonylurea) (Second Gen.)
**Mech**.: Interferes w/ATP-sensitive $K^+$ channel. Reduced $K^+$ conductance → depolarization & influx of $Ca^{2+}$. Stim. of insulin release from pancreas, ↓ glucagon, ↑ binding of insulin to target tissue receptors.
**Absorption**: Oral.
**Dist**.: Largely bound to plasma proteins.
**Metab**.: Hepatic.
**Excret.**, **t_**: Intermed. duration of action (t_=1.5-5 hr), but duration of effect 24 hr.
**Toxicity/S.E.s**: Severe side effects in 2-4%. Only 10% still use them after 6-9 yrs of treatment. Sustained hypoglycemia up to 4-5 days after discontinued use. Rash (rare), GI upset (3-4%), hematological disturbance—usu. leukopenia (1%), inappropriate ADH release (→ hyponatremia), flushing, disulfiram action, variability in steady state conc. Drug interactions—protein binding (alcohol, β blockers, MAO inhibitors)l.
**Utility**: NIDDM—prevents acute hyperglycemic problems, may postpone development of glucose intolerance, may delay thickening of capillary BM.
**Special Features**: More lipophilic and 100x more potent than first gen.

**Name**: **Glipizide (Glucotrol)**
**Class**: Anti-Diabetes Agent (Oral Hypoglycemic) (Sulfonylurea) (Second Gen.)
**Mech**.: Interferes w/ATP-sensitive $K^+$ channel. Reduced $K^+$ conductance → depolarization & influx of $Ca^{2+}$. Stim. of insulin release from pancreas, ↓ glucagon, ↑ binding of insulin to target tissue receptors.
**Absorption**: Oral.
**Dist**.: Largely bound to plasma proteins.
**Metab**.: Hepatic.
**Excret.**, **t_**: Intermed. duration of action (t_=1.5-5 hr), but duration of effect 18 hr.
**Toxicity/S.E.s**: Severe side effects in 2-4%. Only 10% still use them after 6-9 yrs of treatment. Sustained hypoglycemia up to 4-5 days after discontinued use. Rash (rare), GI upset (3-4%), hematological disturbance—usu. leukopenia (1%), inappropriate ADH release (→ hyponatremia), flushing, disulfiram action, variability in steady state conc. Drug interactions—protein binding (alcohol, β blockers, MAO inhibitors)l.
**Utility**: NIDDM—prevents acute hyperglycemic problems, may postpone development of glucose intolerance, may delay thickening of capillary BM.
**Special Features**: More lipophilic and 100x more potent than first gen.

**Name**: **Metformin (Glucophage)**
**Class**: Anti-Diabetes Agent (Oral Hypoglycemic) (Biguanide)
**Mech**.: Decreases hepatic output → decreased plasma glucose. Does not directly stimulate insulin production.
**Absorption**: Oral → good absorption.
**Dist**.: No protein binding.
**Metab**.:
**Excretion**, **t_**: Excreted unmetabolized in urine. 8 hr.
**Toxicity/S.E.s**: Lactic acidosis (1:40,000-80,000), metallic aftertaste, nausea, diarrhea. May reduce triglycerides.
**Utility**: Use alone or in combination w/sulfonylureas to treat NIDDM that doesn't respond well to sulfonylureas alone.
**Special Features**: Only reduces blood glucose in the presence of hyperglycemia. Has not been found to cause serious hypoglycemia.

**Name**: **Acarbose (Precose)**

**Class**: Anti-Diabetes Agent (Oral Hypoglycemic)

**Mech**.: Inhibits $\alpha$-glucosidase → ↓ conversion of carbohydrates to glucose in the small intestine → ↓ absorption of glucose → ↓ post-prandial glucose rise. Does not stimulate insulin release or action. ∴ No hypoglycemia.

**Absorption**: Oral → poor absorption.

**Dist**.:

**Metab**.:

**Excretion**, **t_**:

**Toxicity/S.E.s**: Flatulence, diarrhea, abdominal cramping.

**Utility**: Treat NIDDM. Possible adjunct to insulin for IDDM.

**Special Features**:

**Name**: **Troglitazone**

**Class**: Anti-Diabetes Agent (Oral Hypoglycemic)

**Mech**.: ↑ glucose utilization and reduces production by ↑ receptor response to insulin.

**Absorption**:

**Dist**.:

**Metab**.:

**Excretion**, **t_**:

**Toxicity/S.E.s**:

**Utility**: May help prevent development of NIDDM.

**Special Features**:

**Name**: **Thiazides**

**Class**: Diuretic

**Mech**.: ↓ reabsorption of $Na^+$ in distal tubule by inhibition of a $Na^+/Cl^-$ cotransporter on the luminal membrane. Promotes reabsorption of $Ca2^+$ → ↓ $Ca^{2+}$ in urine.

**Absorption**:

**Dist**.:

**Metab**.:

**Excretion**, **t_**:

**Toxicity/S.E.s**: Potassium depletion, hyperuricemia, volume depletion, hypercalcemia, hyperglycemia, hypersensitivity.

**Utility**: Treat hypertension, congestive heart failure, renal impairment, hypercalciuria, diabetes insipidus.

**Special Features**:

**Name**: **Furosemide (Lasix)**

**Class**: Loop Diuretic

**Mech**.: Inhib. $Na^+/K^+/Cl^-$ cotransport of the luminal membrane in the ascending limb of the loop of Henle → ↓ reabsorption of $Na^+$, $K^+$, & $Cl^-$. Increases conc. of $Ca^{2+}$ in urine.

**Absorption**:

**Dist**.:

**Metab**.:

**Excretion**, **t_**:

**Toxicity/S.E.s**: Ototoxicity, hyperuricemia, acute hypovolemia, potassium depletion.

**Utility**: DOC for reducing acute pulmonary edema of congestive heart failure. Rapid onset, so useful in emergency situations. Treat hypercalcemia.

**Special Features**: