



FIGURE 72-7 Responses to decreases in calcium intake. **A**, The acute response. **B**, The chronic response. Details are provided in the text. GI, Gastrointestinal; PTH, parathyroid hormone.

TABLE 72-1 THERAPEUTIC PHOSPHORUS PREPARATIONS

PREPARATION	COMPOSITION* (per mL)	pH	mOsm/ kg H ₂ O	PHOSPHATE (mmol/mL)	PHOSPHORUS (mg/mL)	SODIUM (mEq/mL)	POTASSIUM (mEq/mL)
ORAL							
Cow's milk (whole)	—	—	288	0.029	0.9	0.025	0.035
Neutra-Phos [†]	Na ₂ HPO ₄ , NaH ₂ PO ₄ , K ₂ HPO ₄ , KH ₂ PO ₄	7.3	—	0.107	3.33	0.095	0.095
Phospho-Soda [†]	180 mg Na ₂ HPO ₄ • 7H ₂ O + 480 mg NaH ₂ PO ₄ • H ₂ O	4.8	8240	4.150	128.65	4.822	0
Acid sodium phosphate	136 mg Na ₂ HPO ₄ • 7H ₂ O + 58.8 mg H ₃ PO ₄ (NF 85%)	4.9	1740	1.018	35.54	1.015	0
Neutral sodium phosphate	145 mg Na ₂ HPO ₄ • 7H ₂ O + 18.2 mg NaH ₂ PO ₄ • H ₂ O	7.0	1390	0.673	20.86	1.214	0
PARENTERAL							
Neutral sodium phosphate	10.07 mg Na ₂ HPO ₄ + 2.66 mg NaH ₂ PO ₄ • H ₂ O	7.35	202	0.090	2.80	0.161	0
Neutral sodium, potassium phosphate	11.5 mg Na ₂ HPO ₄ + 2.58 mg KH ₂ PO ₄	7.4	223	0.100	3.10	0.162	0.019
Sodium phosphate [†]	142 mg Na ₂ HPO ₄ + 276 mg NaH ₂ PO ₄ • H ₂ O	5.7	5580	3.000	93.00	4.000	0
Potassium phosphate [†]	236 mg K ₂ HPO ₄ + 224 mg KH ₂ PO ₄	6.6	5840	3.003	93.11	0	4.360

From Lentz RD, Brown DM, Kjellstrand CM: Treatment of severe hypophosphatemia, *Ann Intern Med* 89:941-944, 1978.

H₂O, Water; K₂HPO₄, dipotassium hydrogen phosphate; KH₂PO₄, potassium dihydrogen phosphate; Na₂HPO₄, disodium hydrogen phosphate; NaH₂PO₄, sodium dihydrogen phosphate.

*Hydration states are important. For example, 268 mg Na₂HPO₄ • 7H₂O (molecular weight 268) equals 1.00 mmol, whereas 268 mg Na₂HPO₄ (molecular weight 142) equals 1.89 mmol.

[†]Commercial preparations: Neutra-Phos, Willen Drug Company, Baltimore, Md. (Neutra-Phos K has twice as much potassium and no sodium); Phospho-Soda, C.B. Fleet Company, Lynchburg, Va. (enema is one-third the strength of Phospho-Soda and can be used orally); sodium phosphate, Abbott Laboratories, North Chicago, Ill.; potassium phosphate, Invenex Pharmaceuticals, Grand Island, N.Y., or Abbott Laboratories. Because Neutra-Phos was not readily dissolved and its specific composition is unknown, data shown are those provided by the manufacturer.

PHOSPHATE HOMEOSTASIS

Phosphorus is an inorganic element, abbreviated as *P* in physical chemistry literature and as *Pi* in physiologic use. The biologically relevant molecule is the negatively charged, trivalent phosphate ion (PO₄). Phosphorus is the form that most clinical laboratories measure rather than the more biologically relevant phosphate ion.

Phosphate is an important physiologic buffer, and at neutral pH in blood, phosphate is apportioned between HPO₄ (divalent) and H₂PO₄ (monovalent). Physicians need to be aware that phosphorus measurements in blood are reported in milligrams per deciliter (mg/dL), whereas pharmaceutical preparations list phosphorus in millimoles (mmol). A chart converting milligrams to millimoles for some common phosphate-containing preparations is

provided in [Table 72-1](#). These values and total doses should be reviewed for the specific phosphorus preparation being prescribed in consultation with the pharmacist and hospital formulary if necessary.

Phosphate regulates or participates in the regulation of an enormous number of biologic processes fundamental to life. They include being an integral component of the DNA double helix, shuttling oxygen from hemoglobin to cells and vice versa using 2,3-diphosphoglycerate (2,3-DPG), intracellular signaling through kinases that attach phosphate groups to other molecules, facilitating critical intracellular messenger systems such as cyclic monophosphate (cAMP) and inositol phosphates, maintaining basic intracellular redox status through the nicotinamide adenine dinucleotide phosphate (NADP-NADPH) system, and serving