Phosphates also have **other uses**. They lower the pH of urine and have been given as adjuncts to urinary antibacterials that depend on an acid urine for their activity. Phosphates have also been used for the prophylaxis of calcium renal calculi; the phosphates reduce urinary excretion of calcium thus preventing calcium deposition. A suggested oral dose for both uses is 7.4 mmol of phosphate four times daily.

Butafosfan (1-butylamino-1-methylethylphosphinic acid) and the sodium salt of toldimfos (4-dimethylamino-*O*-tolylphosphinic acid) are used as phosphorus sources in veterinary medicine.

Bowel evacuation. A review concluded that the efficacy and tolerability of oral sodium phosphate solution was generally similar to, or significantly better than, that of polyethylene glycol-based or other colorectal cleansers in patients preparing for colorectal-related procedures.[1]

1. Curran MP, Plosker GL. Oral sodium phosphate solution: a review of its use as a colorectal cleanser. *Drugs* 2004; **64:** 1697–1714.

Hypercalcaemia. Intravenous phosphates have been used to lower plasma-calcium concentrations in hypercalcaemic emergencies (p.1668), but because of their potential to cause serious adverse effects other drugs are now preferred. Oral phosphates may be used to prevent gastrointestinal absorption of calcium in the treatment of hypercalcaemia. The dose in adults is up to 100 mmol phosphate daily adjusted according to response.

Hypophosphataemia. Phosphate salts are given in the management of hypophosphataemia when a phosphate deficiency is identified, as discussed in Uses and Administration, above. Intravenous phosphates are associated with serious adverse effects if hypophosphataemia is over-corrected, and the rise in serum-phosphorus concentration cannot be predicted from a given dose. Consequently, it has been recommended[1-4] that intravenous phosphate be used cautiously in the treatment of severe hypophosphataemia (for the standard rate and dose see Uses and Administration, above). However, some advocate a more aggressive fixed-dose regimen in critically ill patients.[5-7]

1. Vannatta JB, *et al.* Efficacy of intravenous phosphorus therapy in the severely hypophosphataemic patient. *Arch Intern Med* 1981; **141:** 885–7.
2. Anonymous. Treatment of severe hypophosphatemia. *Lancet* 1981; **ii:** 734.
3. Lloyd CW, Johnson CE. Management of hypophosphatemia. *Clin Pharm* 1988; **7:** 123–8.
4. Coyle S, *et al.* Treatment of hypophosphataemia. *Lancet* 1992; **340:** 977.
5. Perreault MM, *et al.* Efficacy and safety of intravenous phosphate replacement in critically ill patients. *Ann Pharmacother* 1997; **31:** 683–8.
6. Miller DW, Slovis CM. Hypophosphatemia in the emergency department therapeutics. *Am J Emerg Med* 2000; **18:** 457–61.
7. Charron T, *et al.* Intravenous phosphate in the intensive care unit: more aggressive repletion regimens for moderate and severe hypophosphatemia. *Intensive Care Med* 2003; **29:** 1273–8.

Osteomalacia. Vitamin D deficiency, or its abnormal metabolism, is the most usual cause of osteomalacia and rickets (p.1084); however, phosphate depletion may also contribute, and phosphate supplementation may be given as appropriate. A suggested oral dose for vitamin-D-resistant hypophosphataemic osteomalacia in adults is 65 to 100 mmol phosphate daily, and for vitamin D-resistant rickets in children is 32 to 48 mmol phosphate daily.

RICKETS OF PREMATURITY. Dietary deficiency of phosphorus is unusual, but can occur in small premature infants fed exclusively on human breast milk. The phosphate intake in these infants appears to be inadequate to meet the needs of bone mineralisation, and hypophosphataemic rickets can develop. It has been proposed that this condition, variably called metabolic bone disease of prematurity, or rickets of prematurity, could be prevented by giving phosphorus supplements to very low-birth-weight babies (less than about 1000 g) fed on breast milk alone.[1] A suggested regimen is to add 10 to 15 mg of phosphorus per 100 mL of feed (as buffered sodium phosphate) until the infant reached 2000 g. Concomitant calcium and vitamin D supplementation are also recommended.[1] A placebo-controlled study[2] in infants weighing less than 1250 g at birth confirmed that phosphate supplements (50 mg daily) could prevent the development of the bone defects of rickets of prematurity.

1. Brooke OG, Lucas A. Metabolic bone disease in preterm infants. *Arch Dis Child* 1985; **60:** 682–5.
2. Holland PC, *et al.* Prenatal deficiency of phosphate, phosphate supplementation, and rickets in very-low-birthweight infants. *Lancet* 1990; **335:** 697–701. Correction. *ibid.*; 1408–9.

Preparations

BP 2008: Dipotassium Hydrogen Phosphate Injection; Phosphates Enema; Sterile Potassium Dihydrogen Phosphate Concentrate;
Ph. Eur.: Anticoagulant Citrate-Phosphate-Glucose Solution (CPD);
USP 31: Anticoagulant Citrate Phosphate Dextrose Adenine Solution; Anticoagulant Citrate Phosphate Dextrose Solution; Potassium Phosphates Injection; Sodium Phosphates Injection; Sodium Phosphates Oral Solution; Sodium Phosphates Rectal Solution.

Proprietary Preparations (details are given in Part 3)
Arg.: Dicofan; Enemol; Fleet Enema†; Fosfacol; Fosfafarma; Fosfo-Dom; Fosfoadital; Fosfobarigraf; Gadolax; Kritel Enema; Prontonema; Silaxa; Tekfema; ***Austral.:*** Celloids PP 85; Celloids SP 96; Fleet Phospho-Soda; Fleet Ready-to-Use; Phosphate-Sandoz; Phosphoprep; ***Austria:*** Fleet Phospho-Soda; Relaxyl; ***Belg.:*** Colexklysma; Fleet Enema; Fleet Phospho-Soda; Practo-Clyss; ***Braz.:*** Fleet Enema; Phosfoenema; ***Canad.:*** Fleet Enema; Fleet Phospho-Soda; ***Chile:*** Fabulaxol; Fleet Enema; Fleet Fosfosoda; ***Denm.:*** Fleet; ***Fin.:*** K-Fosfosteril†; ***Fr.:*** Fleet Phospho-Soda; ***Ger.:*** Fleet Phospho-Soda; ***Gr.:*** Bioklysm; Enema Cooper; Fleet Enema; Fosfolax; Klysmol; ***Hong Kong:*** Fleet Enema; Fleet Phospho-Soda; Unima; ***Hung.:*** Fleet Phospho-Soda; Optacid; ***India:*** Exit; ***Indon.:*** Fleet Enema; Fleet Phosposoda; ***Irl.:*** Fleet; ***Israel:*** Fleet Enema; ***Ital.:*** Clisma Fleet; Fosfo-Soda Fleet; ***Malaysia:*** Fleet Enema; Fleet Phospho-Soda; ***Mex.:*** Deplecat†; Fleet Enema Fosf-Sodio; Fleet PS; ***Neth.:*** Fleet Gebruiksklaar Klysma; Phosphoral; ***NZ:*** Fleet Phosphate Enema; Fleet Phospho-Soda; ***Philipp.:*** Fleet Enema; Phospho-Soda; ***Pol.:*** Enema; Fleet Phospho-Soda; Phospho-Laxative; Rectanal; ***Port.:*** Fleet Enema; Fleet Phospho-Soda; ***Singapore:*** Fleet Enema†; Fleet Phospho-Soda†; ***Spain:*** Fosfoevac; Fosfosoda; ***Swed.:*** Phosphoral; ***Turk.:*** BT Enema; Fleet Enema; Fleet Fosfo Soda; ***UK:*** Fleet Phospho-Soda; Fleet Ready-to-Use; ***USA:*** Fleet Enema; Fleet Phospho-Soda; K-Phos Original; OsmoPrep; Visicol; ***Venez.:*** Fleet Enema; Fleet Fosfosoda.

Multi-ingredient: ***Arg.:*** Colonil; ***Austral.:*** Cal Alkyline; Celloid Compounds Magcal Plus; Celloid Compounds Sodical Plus; Duo Celloids PPIP; Duo Celloids PPMP; Duo Celloids SPCF; Duo Celloids SPCP; Duo Celloids SPIP; Duo Celloids SPMP; Duo Celloids SPPC; Duo Celloids SPPP; Duo Celloids SPPS; Duo Celloids SPS; Duo Celloids SPSS; Gingo A†; Ginkgo Plus Herbal Plus Formula 10†; Lifesystem Herbal Plus Formula 11 Ginkgo†; Lifesystem Herbal Plus Formula 2 Valerian†; Magnesium Plus†; ML 20†; Potasi; Travad†; Valerian Plus Herbal Plus Formula 12†; ***Austria:*** Clysmol; Prepacol; Reducto; ***Belg.:*** Lavement au Phosphate†; Prepacol; ***Braz.:*** Digestron†; ***Canad.:*** Enemol; Gent-L-Tip†; Normo Gastryl; Phosphate-Novartis; Phosphates; ***Cz.:*** Blend-a-Med†; Mopasol; Prepacol; ***Denm.:*** Phosphoral; ***Fin.:*** Phosphoral; ***Fr.:*** Bactident; Digedryl; Hepargitol; Normacol Lavement; Normogastryl†; Oxyboldine; Phosphoneuros; Phosphore Medifa; Prefagyl†; Prepacol; Tavag; ***Ger.:*** Isogutt†; Klistier; Klysma Salinisch†; Lecicarbon; Practo-Clyss; Prepacol; Reducto-spezial; ***Gr.:*** Enter-Out; Fleet Phospho-Soda; Kathargon; Mineralin; Phospho-Laxat; Phosphoclean; Trifalac; ***Hong Kong:*** PMS-Enemol†; ***Hung.:*** Nilacid; Vition; ***India:*** Cotaryl; ***Indon.:*** Fosen; Kalkurenal; ***Irl.:*** Fletchers Phosphate Enema; ***Israel:*** Calciless; Soffodex; ***Ital.:*** Clisflex; Clisma-Lax; Enemac; IperClean; Phospho-Lax; Pomag; ***Malaysia:*** Unima; ***Mex.:*** Travad†; ***Neth.:*** Colex; ***Norw.:*** Phosphoral; ***NZ:*** Phosphate-Sandoz; ***Pol.:*** Phosphor; Sal Ems Artificiale; Sal Ems Factitium; Sal Vichy Factitium; ***S.Afr.:*** Colo-Prep; Lenolax; Phosphate-Sandoz; Sabax Fosenema; ***Singapore:*** ENTsol; ***Spain:*** Alcalinos Gelos; Darmen Salt; Enema Casen; Eupeptina; Foslainco; Lebersal; ***Switz.:*** Colophos; Freka-Clyss; Lecicarbon; Practo-Clyss†; ***Thai.:*** Swiff; Uni-Ma; ***UK:*** Carbalax; Fletchers Phosphate Enema†; Phosphate-Sandoz; Salivix; ***USA:*** K-Phos MF; K-Phos Neutral; K-Phos No.2; MSP-Blu; Neutra-Phos; Neutra-Phos-K; Phos-NaK; Summers Eve Post-Menstrual; Urelle; Uretron; Urimar-T; Urimax; UriSym†; Uro Blue; Urogesic Blue; Utira; ***Venez.:*** Fisiolin; Polantac.

Potassium

Kalium; Potasio.
K = 39.0983.

Description. Potassium salts covered in this section are those principally given as a source of potassium ions, but consideration should also be given to the effect of the anion. Phosphate salts of potassium are covered under Phosphate, p.1682, and the bicarbonate and citrate salts under Bicarbonate, p.1673.

Potassium Acetate

E261; Kalii acetas; Kalio acetatas; Kaliumacetat; Kálium-acetát; Kaliumasetaatti; Octan draselný; Potasio, acetato de; Potassium, acétate de; Potasu octan.
$CH_3.CO_2K$ = 98.14.
CAS — 127-08-2.

Pharmacopoeias. In *Eur.* (see p.vii) and *US*.
Ph. Eur. 6.2 (Potassium Acetate). Deliquescent white or almost white, crystalline powder or colourless crystals. Very soluble in water; freely soluble in alcohol. A 5% solution in water has a pH of 7.5 to 9.0. Protect from moisture.
USP 31 (Potassium Acetate). Colourless, monoclinic crystals, or a white crystalline powder. It is odourless or has a faint acetous odour. Deliquesces on exposure to moist air. Soluble 1 in 0.5 of water, 1 in 0.2 of boiling water, and 1 in 3 of alcohol. pH of a 5% solution in water is between 7.5 and 8.5. Store in airtight containers.

Equivalence. Each g of potassium acetate (anhydrous) represents about 10.2 mmol of potassium. Potassium acetate (anhydrous) 2.51 g is equivalent to about 1 g of potassium.

Potassium Aspartate

Aspartate monopotassique hémihydraté; Kalii hydrogenoaspartas hemihydricus; Kalio-divandenilio aspartatas hemihidratas; Kalium-hydrogen-aspartát hemihydrát; Kaliumväteaspartathemihydrat; Kaliumvetyaspartaattihemihydraatti; Potassium Hydrogen Aspartate Hemihydrate. Potassium aminosuccinate hemihydrate.
$C_4H_6KNO_4,\ ½H_2O$ = 180.2.
CAS — 7259-25-8 (hemihydrate).

Pharmacopoeias. In *Eur.* (see p.vii).
Ph. Eur. 6.2 (Potassium Hydrogen Aspartate Hemihydrate). A white or almost white, powder or crystalline powder, or colourless crystals. Very soluble in water; practically insoluble in alcohol and in dichloromethane. pH of a 2.5% solution in water is between 6.0 and 7.5.

Equivalence. Each g of potassium aspartate represents about 5.5 mmol of potassium. Potassium aspartate 4.61 g is equivalent to about 1 g of potassium.

Potassium Chloride

Chlorid draselný; Cloreto de Potássio; E508; Kalii chloridum; Kalio chloridas; Kalium Chloratum; Kaliumklorid; Kálium-klorid; Kaliumkloridi; Potasio, cloruro de; Potassium, chlorure de; Potasu chlorek.
KCl = 74.55.
CAS — 7447-40-7.
ATC — A12BA01; B05XA01.
ATC Vet — QA12BA01; QB05XA01.

Pharmacopoeias. In *Chin.*, *Eur.* (see p.vii), *Int.*, *Jpn*, *US*, and *Viet.*
Ph. Eur. 6.2 (Potassium Chloride). A white or almost white, crystalline powder or colourless crystals. Freely soluble in water; practically insoluble in dehydrated alcohol.
USP 31 (Potassium Chloride). Colourless, elongated, prismatic, or cubical crystals, or a white, granular powder. Is odourless. Soluble 1 in 2.8 of water, and 1 in 2 of boiling water; insoluble in alcohol. Its solutions are neutral to litmus.

Equivalence. Each g of potassium chloride represents about 13.4 mmol of potassium. Potassium chloride 1.91 g is equivalent to about 1 g of potassium.

Potassium Gluconate

E577; Potasio, gluconato de. Potassium D-gluconate.
$CH_2OH.[CH(OH)]_4.CO_2K$ = 234.2.
CAS — 299-27-4 (anhydrous potassium gluconate); 35398-15-3 (potassium gluconate monohydrate).
ATC — A12BA05.
ATC Vet — QA12BA05.

Pharmacopoeias. In *Fr.*
US permits anhydrous or the monohydrate.
USP 31 (Potassium Gluconate). It is anhydrous or contains one molecule of water of hydration. A white or yellowish-white, odourless, crystalline powder or granules. Soluble 1 in 3 of water; practically insoluble in dehydrated alcohol, in chloroform, in ether, and in benzene. Its solutions are slightly alkaline to litmus. Store in airtight containers.

Equivalence. Each g of potassium gluconate (anhydrous) represents about 4.3 mmol of potassium. Each g of potassium gluconate (monohydrate) represents about 4 mmol of potassium. Potassium gluconate (anhydrous) 5.99 g and potassium gluconate (monohydrate) 6.45 g are each equivalent to about 1 g of potassium.

Potassium Sulfate

E515; Kalii sulfas; Kalio sulfatas; Kalium Sulfuricum; Kaliumsulfaatti; Kaliumsulfat; Potasio, sulfato de; Potassii Sulphas; Potassium, sulfate de; Potassium Sulphate; Síran draselný; Tartarus Vitriolatus.
K_2SO_4 = 174.3.
CAS — 7778-80-5.

Pharmacopoeias. In *Eur.* (see p.vii) and *Jpn*.
Ph. Eur. 6.2 (Potassium Sulphate). A white or almost white, crystalline powder or colourless crystals. Soluble in water; practically insoluble in dehydrated alcohol.

Equivalence. Each g of potassium sulfate represents about 11.5 mmol of potassium. Potassium sulfate 2.23 g is equivalent to about 1 g of potassium.

Potassium Tartrate

E336; Potasio, tartrato de; Potasu winian.
$C_4H_4K_2O_6,\ ½H_2O$ = 235.3.
CAS — 921-53-9 (anhydrous potassium tartrate).

Equivalence. Each g of potassium tartrate (hemihydrate) represents about 8.5 mmol of potassium. Potassium tartrate (hemihydrate) 3.00 g is equivalent to about 1 g of potassium.

Adverse Effects

Excessive doses of potassium may lead to the development of hyperkalaemia (p.1669), especially in patients with renal impairment. Symptoms include paraesthesia of the extremities, muscle weakness, paralysis, cardiac arrhythmias, heart block, cardiac arrest, and confusion. Cardiac toxicity is of particular concern after intravenous dosage.

Pain or phlebitis may occur when given intravenously via peripheral veins, particularly at higher concentrations.

Nausea, vomiting, diarrhoea, and abdominal cramps may occur with oral potassium salts. There have been numerous reports of gastrointestinal ulceration, sometimes with haemorrhage and perforation or with the late formation of strictures, after the use of enteric-