### Penethamate Hydriodide *(BAN)*

Diethylaminoethyl Penicillin G Hydroiodide; Penetamato, hidroioduro de; Pénéthamate, iodhydrate de; Penethamati hydroiodidum. 2-Diethylaminoethyl (6*R*)-6-(2-phenylacetamido)penicillanate hydriodide.

$C_{22}H_{31}N_3O_4S,HI$ = 561.5.

*CAS — 3689-73-4 (penethamate); 808-71-9 (penethamate hydriodide).*

*ATC Vet — QJ01CE90; QJ51CE90.*

**Profile**

Penethamate is a penicillin antibacterial used as the hydriodide in veterinary medicine.

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### Pheneticillin Potassium *(BANM, rINNM)*

Feneticilina potásica; Kalii Pheneticillinum; Penicillin B; Phenethicillin Potassium; Phénéticilline Potassique; Pheneticillinum Kalicum; Potassium α-Phenoxyethylpenicillin. A mixture of the D(+)- and L(−)-isomers of potassium (6*R*)-6-(2-phenoxypropionamido)penicillanate.

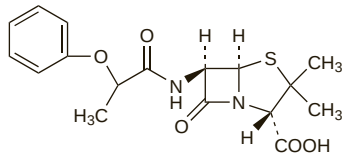
Калия Фенетициллин

$C_{17}H_{19}KN_2O_5S$ = 402.5.

*CAS — 147-55-7 (pheneticillin); 132-93-4 (pheneticillin potassium).*

*ATC — J01CE05.*

*ATC Vet — QJ01CE05.*



*(pheneticillin)*

**Pharmacopoeias.** In *Jpn.*

**Profile**

Pheneticillin is a phenoxypenicillin with actions and uses similar to those of phenoxymethylpenicillin (below). It has been given orally, as the potassium salt, for the treatment of susceptible mild to moderate infections. Pheneticillin sodium has also been used.

**Preparations**

**Proprietary Preparations** (details are given in Part 3)
***Neth.:*** Broxil.

---

## Phenoxymethylpenicillin *(BAN, rINN)*

Fenoksimetilpenicilinas; Fenoksimetyylipenisilliini; Fenoksymetylopenicylina; Fenoximetilpenicilina; Fenoximetilpenicillin; Fenoximetylpenicillin; Fenoxymethylpenicilin; Penicillin, Phenoxymethyl; Penicillin V *(USAN)*; Penisilin V; Phénomycilline; Phenoxymethyl Penicillin; Phénoxyméthylpénicilline; Phenoxymethylpenicillinum. (6*R*)-6-(2-Phenoxyacetamido)penicillanic acid.

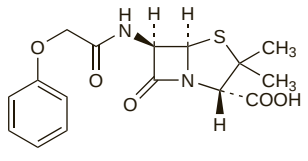
Феноксиметилпенициллин

$C_{16}H_{18}N_2O_5S$ = 350.4.

*CAS — 87-08-1.*

*ATC — J01CE02.*

*ATC Vet — QJ01CE02.*



**Pharmacopoeias.** In *Eur.* (see p.vii), *Int., US,* and *Viet.*
**Ph. Eur. 6.2** (Phenoxymethylpenicillin). A substance produced by the growth of certain strains of *Penicillium notatum* or related organisms on a culture medium containing an appropriate precursor, or obtained by any other means. A white or almost white, slightly hygroscopic, crystalline powder. Very slightly soluble in water; soluble in alcohol. A 0.5% suspension in water has a pH of 2.4 to 4.0. Store in airtight containers.
**USP 31** (Penicillin V). A white, odourless crystalline powder. Very slightly soluble in water; freely soluble in alcohol and in acetone; insoluble in fixed oils. pH of a 3% suspension in water is between 2.5 and 4.0. Store in airtight containers.

### Phenoxymethylpenicillin Calcium *(BANM, rINNM)*

Calcii Phenoxymethylpenicillinum; Fenoximetilpenicilina cálcica; Penicillin V Calcium; Phénoxyméthylpénicilline Calcique; Phenoxymethylpenicillinum Calcicum.

Кальций Феноксиметилпенициллин

$(C_{16}H_{17}N_2O_5S)_2Ca,2H_2O$ = 774.9.

*CAS — 147-48-8 (anhydrous phenoxymethylpenicillin calcium); 73368-74-8 (phenoxymethylpenicillin calcium dihydrate).*

*ATC — J01CE02.*

*ATC Vet — QJ01CE02.*

**Pharmacopoeias.** In *Int.*

### Phenoxymethylpenicillin Potassium *(BANM, rINNM)*

Fenoksimetil Penisilin Potasyum; Fenoksimetilpenicilino kalio druska; Fenoksimetyylipenisilliinikalium; Fenoksymetylopenicylina potasowa; Fenoximetilpenicilina potásica; Fenoximetilpenicilina Potássica; Fenoximetilpenicillin-kálium; Fenoximetylpenicillin kalium; Fenoxymethylpenicilin draselná sůl; Kalii Phenoxymethylpenicillinum; Penicillin V Potassium *(USAN)*; Phénoxyméthylpénicilline potassique; Phenoxymethylpenicillinum kalicum.

Калия Феноксиметилпенициллин

$C_{16}H_{17}KN_2O_5S$ = 388.5.

*CAS — 132-98-9.*

*ATC — J01CE02.*

*ATC Vet — QJ01CE02.*

**Pharmacopoeias.** In *Chin., Eur.* (see p.vii), *Int., US,* and *Viet.*
**Ph. Eur. 6.2** (Phenoxymethylpenicillin Potassium). A white or almost white, crystalline powder. Freely soluble in water; practically insoluble in alcohol. A 0.5% solution in water has a pH of 5.5 to 7.5.
**USP 31** (Penicillin V Potassium). A white, odourless crystalline powder. Very soluble in water; soluble 1 in 150 of alcohol; insoluble in acetone. pH of a 3% solution in water is between 4.0 and 7.5. Store in airtight containers.

### Units

The first International Standard Preparation (1957) of phenoxymethylpenicillin contained 1695 units/mg but was withdrawn in 1968. Despite this, doses of phenoxymethylpenicillin are still expressed in units in some countries.

Phenoxymethylpenicillin 250 mg is equivalent to about 400 000 units.

### Adverse Effects and Precautions

As for Benzylpenicillin, p.213.

Phenoxymethylpenicillin is usually well tolerated but may occasionally cause transient nausea and diarrhoea.

**Potassium content.** Each g of phenoxymethylpenicillin potassium contains about 2.6 mmol of potassium.

### Interactions

As for Benzylpenicillin, p.214.

**Antibacterials.** Reduced absorption was reported when phenoxymethylpenicillin was given after an oral course of *neomycin*.[1]

1. Cheng SH, White A. Effect of orally administered neomycin on the absorption of penicillin V. *N Engl J Med* 1962; **267:** 1296–7.

**Beta blockers.** Fatal anaphylactic reactions to phenoxymethylpenicillin in 2 patients on *nadolol* and *propranolol* respectively, might have been potentiated by the beta blocker.[1]

1. Berkelman RL, *et al.* Beta-adrenergic antagonists and fatal anaphylactic reactions to oral penicillin. *Ann Intern Med* 1986; **104:** 134.

### Antimicrobial Action

Phenoxymethylpenicillin has a range of antimicrobial activity similar to that of benzylpenicillin (p.214) and a similar mode of action. It may be less active against some susceptible organisms, particularly Gram-negative bacteria.

The mechanisms and patterns of resistance to phenoxymethylpenicillin are similar to those of benzylpenicillin.

### Pharmacokinetics

Phenoxymethylpenicillin is more resistant to inactivation by gastric acid and is more completely absorbed than benzylpenicillin from the gastrointestinal tract. Absorption is usually rapid, although variable, with about 60% of an oral dose being absorbed. The calcium and potassium salts are better absorbed than the free acid. Peak plasma concentrations of 3 to 5 micrograms/mL have been observed 30 to 60 minutes after a dose of 500 mg. The effect of food on absorption appears to be slight. The plasma half-life of phenoxymethylpenicillin is about 30 to 60 minutes and may be increased to about 4 hours in severe renal impairment. About 80% is reported to be protein bound. The distribution and elimination of phenoxymethylpenicillin is similar to that of benzylpenicillin (p.214). It is metabolised in the liver to a greater extent than benzylpenicillin; several metabolites have been identified including penicilloic acid. The unchanged drug and metabolites are excreted rapidly in the urine. Only small amounts are excreted in the bile.

### Uses and Administration

Phenoxymethylpenicillin is used similarly to benzylpenicillin (p.215) in the treatment or prophylaxis of infections caused by susceptible organisms, especially streptococci. It is used only for the treatment of mild to moderate infections, and not for chronic, severe, or deep-seated infections since absorption can be unpredictable. Patients treated initially with parenteral benzylpenicillin may continue treatment with oral phenoxymethylpenicillin once a satisfactory clinical response has been obtained. Specific indications for phenoxymethylpenicillin include anthrax (mild uncomplicated infections), Lyme disease (early stage in pregnant women or young children), pharyngitis or tonsillitis, rheumatic fever (primary and secondary prophylaxis), streptococcal skin infections, and spleen disorders (pneumococcal infection prophylaxis). For details of these infections and their treatment, see under Choice of Antibacterial, p.162.

*Administration and dosage.* Phenoxymethylpenicillin is given orally, usually as the potassium or calcium salt, preferably at least 30 minutes before, or 2 hours after, food. Benzathine phenoxymethylpenicillin (p.212) is also used.

Doses are expressed in terms of the equivalent amount of phenoxymethylpenicillin; 1.1 g of phenoxymethylpenicillin calcium and 1.1 g of phenoxymethylpenicillin potassium are each equivalent to about 1 g of phenoxymethylpenicillin.

Usual adult doses have been 250 to 500 mg every 6 hours, but the *BNF* recommends up to 1 g every 6 hours in severe infections. Children may be given the following doses every 6 hours: up to 1 year, 62.5 mg; 1 to 5 years, 125 mg; and 6 to 12 years, 250 mg. The *BNFC* recommends that doses be increased to ensure at least 12.5 mg/kg every 6 hours in severe infection. Dosage may need to be modified in severe renal impairment.

To prevent recurrences of rheumatic fever, WHO and the *BNF* recommend 250 mg twice daily.

### Preparations

***BP 2008:*** Phenoxymethylpenicillin Oral Solution; Phenoxymethylpenicillin Tablets;
***USP 31:*** Penicillin V for Oral Suspension; Penicillin V Potassium for Oral Solution; Penicillin V Potassium Tablets; Penicillin V Tablets.

**Proprietary Preparations** (details are given in Part 3)
***Arg.:*** Pen Oral; Penagrand; Penfantil; Penicina; ***Austral.:*** Abbocillin-VK; Cilicaine VK; Cilopen VK; LPV; Penhexal VK; ***Austria:*** Aliucillin; Cliacil; Megacillin; Ospen; Pen-V; Penbene; Penoral; Penstad; Star-Pen; ***Belg.:*** Peni-Oral; ***Braz.:*** Meracilina; Oracilin; Pen-V-Cil; Pen-Ve-Oral; Pencilin-V; Penicigran; ***Canad.:*** Apo-Pen-VK; Nadopen-V†; Novo-Pen-VK; Nu-Pen-VK; Pen-Vee†; PVFK†; ***Cz.:*** InfectoCillin†; Megacillin†; Ospen; Penbene; Pencid; ***Denm.:*** Calcipen; Pancillin; Primcillin; Rocilin; Vepicombin; ***Fin.:*** Medicillin; Milcopen; V-Pen; ***Fr.:*** Oracilline; Ospen†; ***Ger.:*** Arcasin; durapenicillin†; InfectoCillin; Isocillin; Ispenoral; Jenacillin V†; Megacillin oral; P-Mega-Tablinen; Pen Mega; Pen†; Penbeta; Penhexal; Penicillat†; V-Tablopen†; ***Gr.:*** Ospen; ***Hong Kong:*** Ospen†; ***Hung.:*** Ospen; Vegacillin†; ***Indon.:*** Fenocin; Ospen; ***Irl.:*** Calvepen; Kopen; ***Israel:*** Rafapen Mega; Rafapen V-K; ***Malaysia:*** Beapen; Ospen; Penoxil V†; ***Mex.:*** Anapenil; Kavipen; Megapenil†; Pen-Vi-K; Pota-Vi-Kin; ***Neth.:*** Acipen; Acipen-V; ***Norw.:*** Apocillin; Calcipen†; Kavepenin†; Rocilin†; Weifapenin; ***NZ:*** Cilicaine VK; ***Philipp.:*** Sumapen; ***Pol.:*** Ospen; ***Rus.:*** Ospen (Оспен); ***S.Afr.:*** Betapen; Deltacillin†; Incil; Len V.K.; Novo V-K†; Rolab-Pen-V-K†; Spec-Pen-V-K; ***Singapore:*** Ospen; ***Spain:*** Penilevel; ***Swed.:*** Kavepenin; Peceve; Tikacillin; ***Switz.:*** Brunocillin†; Megacilline†; Ospen; pen-V-basan†; Penisol; Phenocillin; Stabicilline; ***Thai.:*** Pen-V; Pener; Penveno; Servipen-V†; ***Turk.:*** Cilacil; ***USA:*** Pen-Vee K; Veetids; ***Venez.:*** Ospen.

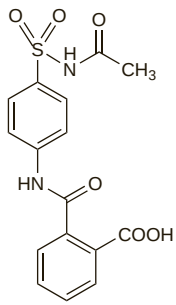
**Multi-ingredient:** ***Spain:*** Penilevel Retard.

### Phthalylsulfacetamide *(BAN)*

Phthalylsulphacetamide; Sulfanilacetamidum Phthalylatum. 4′-(Acetylsulphamoyl)phthalanilic acid.

$C_{16}H_{14}N_2O_6S$ = 362.4.

*CAS — 131-69-1.*



#### Profile

Phthalylsulfacetamide is a sulfonamide antibacterial. It is poorly absorbed when given orally and has been used for gastrointestinal infections.

#### Preparations

**Proprietary Preparations** (details are given in Part 3)

**Multi-ingredient:** ***Braz.:*** Dimicin†; ***Chile:*** Enterol; Enterol Con Nifuroxacida; Kordinol Compuesto†; ***Mex.:*** Facetin-D.

### Phthalylsulfathiazole *(BAN, rINN)*

Ftalilsulfatiazol; Ftalilsulfatiazolas; Ftálilszulfatiazol; Ftalylsulfathiazol; Ftalysulfatiazol; Ftalyylisulfatiatsoli; Phtalylsulfathiazol; Phthalazolum; Phthalylsulfathiazolum; Phthalylsulphathiazole; Sulfaphtalylthiazol. 4′-(1,3-Thiazol-2-ylsulphamoyl)phthalanilic acid.

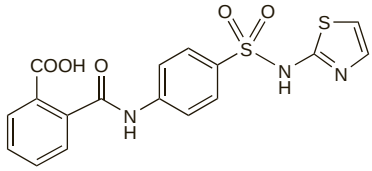
Фталилсульфатиазол

$C_{17}H_{13}N_3O_5S_2$ = 403.4.

*CAS — 85-73-4.*

*ATC — A07AB02.*

*ATC Vet — QA07AB02.*



**Pharmacopoeias.** In *Eur.* (see p.vii) and *Viet.*

**Ph. Eur. 6.2** (Phthalylsulfathiazole). A white or yellowish-white crystalline powder. Practically insoluble in water; slightly soluble in alcohol and in acetone; freely soluble in dimethylformamide. Protect from light.

#### Profile

Phthalylsulfathiazole is a sulfonamide with properties similar to those of sulfamethoxazole (p.340). It is poorly absorbed, about 95% remaining in the intestine and only about 5% being slowly hydrolysed to sulfathiazole and absorbed.

It is given, with other antibacterials, for its antibacterial action in the gastrointestinal tract in the treatment of infections and for bowel decontamination before surgery.

#### Preparations

**Proprietary Preparations** (details are given in Part 3)

**Multi-ingredient:** ***Arg.:*** Antidiar†; Carbon Tabs; Colistop; Colistoral†; Diarrocalmol; Estreptocarbocaftiazol; Gemipasmol†; Lefa Enteril†; Opocarbon; Opoclor†; ***Braz.:*** Parenterin; Sanadiar†; ***Chile:*** Imecol; Liracol; Testisan; ***Mex.:*** Bontal; Ditayod; Sultroquin†; ***Port.:*** Cloranpectina†; ***Spain:*** Estreptoenterol†; ***Thai.:*** Chlorotracin; Coccila†; Disento; Endothalyl; Mediocin†.

### Pipemidic Acid *(BAN, rINN)*

Acide Pipémidique; Ácido pipemídico; Acidum Pipemidicum; Acidum pipemidicum trihydricum; Kyselina pipemidová trihydrát; Pipemidihappo; Pipemidiinihappotrihydraatti; Pipemidinsav-trihidrát; Pipemidinsyratrihydrat; Pipémidique (acide) trihydraté; Pipemido rūgštis trihidratas; Pipemidsyra; Piperamic Acid; I489-RB. 8-Ethyl-5,8-dihydro-5-oxo-2-(piperazin-1-yl)pyrido[2,3-*d*]pyrimidine-6-carboxylic acid.

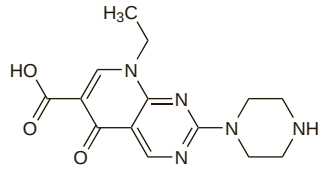
Пипемидовая Кислота

$C_{14}H_{17}N_5O_3$ = 303.3.

*CAS — 51940-44-4 (anhydrous pipemidic acid); 72571-82-5 (pipemidic acid trihydrate).*

*ATC — J01MB04.*

*ATC Vet — QJ01MB04.*



*(anhydrous pipemidic acid)*

**Pharmacopoeias.** In *Chin., Eur.* (see p.vii), and *Jpn* (all as the trihydrate).

**Ph. Eur. 6.2** (Pipemidic Acid Trihydrate). A pale yellow or yellow crystalline powder. Very slightly soluble in water. It dissolves in dilute solutions of acids and of alkali hydroxides. Protect from light.

#### Profile

Pipemidic acid is a 4-quinolone antibacterial with properties similar to those of nalidixic acid (p.303), but is more active *in vitro* against some bacteria, including *Pseudomonas aeruginosa*. It is used (as the trihydrate) in the treatment of urinary-tract infections in oral doses equivalent to 400 mg of the anhydrous substance twice daily.

**Interactions.** For the effect of pipemidic acid on the clearance of xanthines, see under Caffeine, p.1117, and Theophylline, p.1143.

**Porphyria.** Pipemidic acid is considered to be unsafe in patients with porphyria because it has been shown to be porphyrinogenic in *in-vitro* systems.

#### Preparations

**Proprietary Preparations** (details are given in Part 3)

***Arg.:*** Finuret; Memento; Priper; ***Austria:*** Deblaston; ***Braz.:*** Balurol; Elofuran; Pipram; Pipurol; Uroxina; ***Chile:*** Nupra†; Purid; Uropimide; ***Fr.:*** Pipram; ***Ger.:*** Deblaston; ***Hong Kong:*** Urotractin; ***Indon.:*** Impresial; Urinter; Urixin; Urotractin; Utrex; ***Ital.:*** Acipem†; Biosoviran; Cistomid; Diperpen; Faremid; Filtrax†; Pipeacid†; Pipedac; Pipefort; Pipemid; Pipram; Pipurin; Urodene; Uropimid; Urosan; Urosetic; Urotractin; ***Jpn:*** Dolcol; ***Malaysia:*** Urixin†; Urotractin†; ***Mex.:*** Uribac†; Uriken†; Unipiser; Uronovag; Uropipemid; ***Neth.:*** Pipram; ***Philipp.:*** Urixin; ***Pol.:*** Palin; Urolin; ***Rus.:*** Palin (Палин); Pimidel (Пимидель); ***S.Afr.:*** Deblaston; Septidron†; ***Singapore:*** Urotractin; ***Spain:*** Galusan; Nuril; Urisan; Uropipedil; ***Thai.:*** Pipedic†; Urotractin.

**Multi-ingredient:** ***Arg.:*** Priper Plus.

## Piperacillin *(BAN, rINN)*

Piperacilin monohydrát; Piperacilina; Piperacilinas; Pipéracilline; Piperacillinum; Piperacillinum Monohydricum; Piperasilliini. (6*R*)-6-[*R*-2-(4-Ethyl-2,3-dioxopiperazine-1-carboxamido)-2-phenylacetamido]penicillanic acid monohydrate; 3-Dimethyl-7-oxo-4-thia-1-azabicyclo[3.2.0]heptane-2-carboxylic acid monohydrate.

Пиперациллин

$C_{23}H_{27}N_5O_7S,H_2O$ = 535.6.

*CAS — 61477-96-1 (anhydrous piperacillin); 66258-76-2 (piperacillin monohydrate).*

*ATC — J01CA12.*

*ATC Vet — QJ01CA12.*

**Pharmacopoeias.** In *Chin., Eur.* (see p.vii), and *US.*

**Ph. Eur. 6.2** (Piperacillin). A white or almost white powder. Slightly soluble in water and in ethyl acetate; freely soluble in methyl alcohol.

**USP 31** (Piperacillin). A white to off-white crystalline powder. Very slightly soluble in water; slightly soluble in ethyl acetate; sparingly soluble in isopropyl alcohol; very soluble in methyl alcohol.

### Piperacillin Sodium *(BANM, USAN, rINNM)*

CL-227193; Natrii Piperacillinum; Piperacilin sodná sůl; Piperacilina sódica; Piperacilino natrio druska; Pipéracilline sodique; Piperacillin-nátrium; Piperacillinnatrium natricum; Piperacillinum; Piperacillinum natricum; Piperacylina sodowa; Piperasilin Sodyum; Piperasilliininatrium; T-1220.

Натрий Пиперациллин

$C_{23}H_{26}N_5NaO_7S$ = 539.5.

*CAS — 59703-84-3.*

*ATC — J01CA12.*

*ATC Vet — QJ01CA12.*

**Pharmacopoeias.** In *Chin., Eur.* (see p.vii), *Jpn*, and *US.*

**Ph. Eur. 6.2** (Piperacillin Sodium). A white or almost white, hygroscopic powder. Freely soluble in water and in methyl alcohol; practically insoluble in ethyl acetate. A 10% solution in water has a pH of 5.0 to 7.0. Store in airtight containers.

**USP 31** (Piperacillin Sodium). A white to off-white solid. Freely soluble in water and in alcohol. pH of a 40% solution in water is between 5.5 and 7.5. Store in airtight containers.

**Incompatibility.** Piperacillin sodium has been reported to be incompatible with aminoglycosides and sodium bicarbonate.

**Stability.** References.

1. Zhang Y, Trissel LA. Stability of piperacillin and ticarcillin in AutoDose Infusion System bags. *Ann Pharmacother* 2001; **35:** 1360–3.

### Adverse Effects and Precautions

As for Carbenicillin Sodium, p.216.

Prolongation of bleeding time has been less frequent and less severe with piperacillin than with carbenicillin.

**Effects on the blood.** References.

1. Scheetz MH, *et al.* Systematic review of piperacillin-induced neutropenia. *Drug Safety* 2007; **30:** 295–306.

**Hypersensitivity.** In the mid 1980s there were reports of a relatively high incidence of adverse reactions to piperacillin, especially fever, in patients with cystic fibrosis.[1-3] However, the manufacturers[4] considered such patients to be particularly prone to allergy and cited reactions with other semisynthetic penicillins including carbenicillin and azlocillin.

Similar apparent hypersensitivity reactions have been reported in patients taking high doses of piperacillin and other ureidopenicillins, over long periods for other indications,[5] and with other penicillins in patients with cystic fibrosis,[6] although piperacillin does appear to be most frequently implicated.[6]

1. Stead RJ, *et al.* Adverse reactions to piperacillin in cystic fibrosis. *Lancet* 1984; **i:** 857–8.
2. Strandvik B. Adverse reactions to piperacillin in patients with cystic fibrosis. *Lancet* 1984; **i:** 1362.
3. Stead RJ, *et al.* Adverse reactions to piperacillin in adults with cystic fibrosis. *Thorax* 1985; **40:** 184–6.
4. Brock PG, Roach M. Adverse reactions to piperacillin in cystic fibrosis. *Lancet* 1984; **i:** 1070–1.
5. Lang R, *et al.* Adverse reactions to prolonged treatment with high doses of carbenicillin and ureidopenicillins. *Rev Infect Dis* 1991; **13:** 68–72.
6. Pleasants RA, *et al.* Allergic reactions to parenteral beta-lactam antibiotics in patients with cystic fibrosis. *Chest* 1994; **106:** 1124–8.

**Sodium content.** Each g of piperacillin sodium contains about 1.85 mmol of sodium. As piperacillin sodium has a lower sodium content than carbenicillin sodium, hypernatraemia and hypokalaemia are less likely to occur.

### Interactions

As for Benzylpenicillin, p.214.

**Neuromuscular blockers.** Piperacillin and other ureidopenicillins are reported to prolong the action of competitive muscle relaxants such as *vecuronium* (see Atracurium, p.1903).

### Antimicrobial Action

Piperacillin has a similar antimicrobial action to carbenicillin (p.216) and ticarcillin (p.352), but is active against a wider range of Gram-negative organisms, including *Klebsiella pneumoniae*. It is also generally more active *in vitro*, especially against *Pseudomonas aeruginosa* and the Enterobacteriaceae, against Gram-positive *Enterococcus faecalis*, and possibly against *Bacteroides fragilis*. There is, however, an inoculum effect, i.e. minimum inhibitory concentrations of piperacillin increase with the size of the inoculum.

Combinations of piperacillin and aminoglycosides have been shown to be synergistic *in vitro* against *Ps. aeruginosa* and Enterobacteriaceae. The effect of using piperacillin with other beta lactams has been less predictable. The activity of piperacillin against some organisms, resistant because of the production of beta-lactamases, may be restored by tazobactam, a beta-lactamase inhibitor. Such organisms include beta-lactamase-producing strains of staphylococci, *Escherichia coli*, *Haemophilus influenzae*, and *Bacteroides* spp.; the activity of piperacillin against *Ps. aeruginosa* is not enhanced by tazobactam.

Resistance has developed in *Ps. aeruginosa* during treatment with piperacillin, especially when used alone. There may be some cross-resistance with other antipseudomonal penicillins.

◊ References.

1. Higashitani F, *et al.* Inhibition of β-lactamases by tazobactam and in-vitro antibacterial activity of tazobactam combined with piperacillin. *J Antimicrob Chemother* 1990; **25:** 567–74.
2. Mehtar S, *et al.* The in-vitro activity of piperacillin/tazobactam, ciprofloxacin, ceftazidime and imipenem against multiple resistant Gram-negative bacteria. *J Antimicrob Chemother* 1990; **25:** 915–19.
3. Kempers J, MacLaren DM. Piperacillin/tazobactam and ticarcillin/clavulanic acid against resistant Enterobacteriaceae. *J Antimicrob Chemother* 1990; **26:** 598–9.