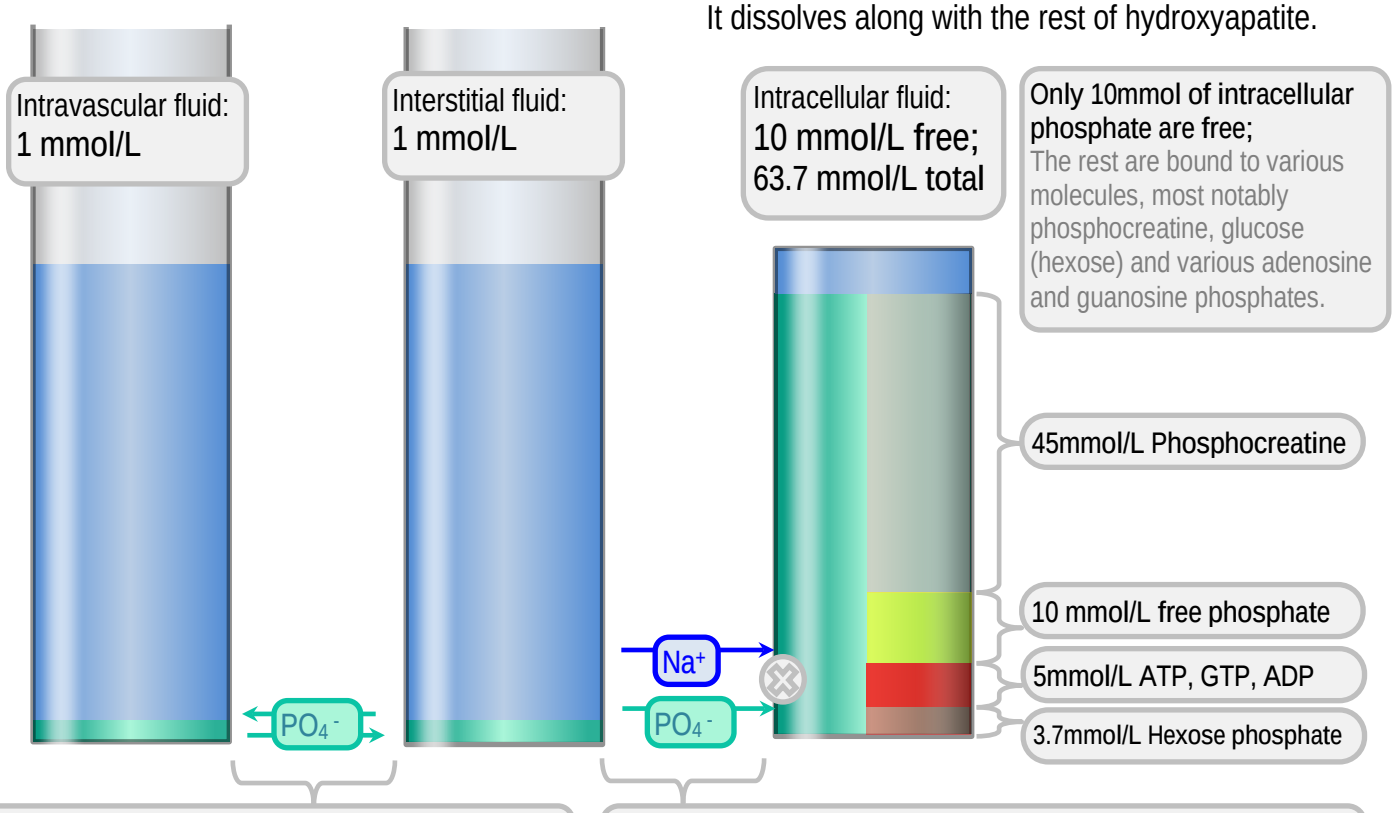
Phosphate in the body fluid compartments

Total body phosphate content

- You have about 320 mmol/Kg of phosphorus.
- A 70kg male has about 22.5 moles of phosphorus, or about 700 g
- Of this, 85% is bound in the hydroxyapatite matrix of bone.
- That's 19.1 moles, or 595g. 300 mg of this is exchanged every day as part of normal bone turnover.
- The other 15% is dissolved, and exists largely as the phosphate ion, PO_4^{3-}
- Say, 14.99% of the remaining 15% is intracellular. That is about 3.4 moles.
- The intracellular concentration is between 60mmol and 100mmol, but only 10mmol are free.
- Phosphate is the most abundant intracellular anion. It acts as an important intracellular buffer.
- The rest is in the extracellular fluid; in total, no more than 12mmol.
- The extracellular concentration is about 1.0mmol/L. This is the only phosphate source to the cells.
- Most of it is present as a univalent species (i.e. with a negative charge of 1). Even though the phosphate ion, when fully ionized, is a trivalent PO_4^{3-} at physiological pH the divalent PO_4^{2-} species is the more prevalent (about 80%), and the univalent PO_4^{-} species is the other 20%. It takes a pH of 6.8 or so to get to a trivalent majority. This only ever happens intracellularly, where the pH is routinely about 6.9.

Its massively unequal distribution

- This pertains to the dissolved phosphate only… Bone phosphate follows the same rules as calcium. It dissolves along with the rest of hydroxyapatite.



Phosphate equilibrates easily between the extracellular fluid compartments. There really isn't anything stopping it. It is strongly anionic, so there is slightly more in the interstitial fluid (as it is repelled by the anionic charge

Phosphate is sucked into the cell by a sodium-phosphate co-transporter, which is more active in the presence of insulin. This process is powered by the awesomely powerful sodium concentration gradient. There are three types (inventively nominated as Type1,2 and 3); the Type 3 co-transporter seems to be the ubiquitous one, which all of the human cells express.

From Ganongs Review of Medical Physiology 23rd edition, Vanders Renal Physiology 7th edition, Wests Respiratory Physiology: the Essentials, as well as public works by the eminent Dr Kerry Brandis to whom I owe much of the inspiration for my shambolic efforts at self-education . Another reference I used was this eMedicine article. For details on phosphorus, please see this beautiful article in the Lancet. This guy from Yale also wrote a beautiful thesis on this topic, to which I tip my hat. Furthermore, see these electrolyte discussions in the Electrolyte Quintet series from the Lancet..