The inert noble gases are anything but inert biologically

The noble gases (helium, neon, argon, krypton, and xenon) present an intriguing scientific paradox. They are extremely inert chemically, and very drastic conditions need to be employed to convert them into other compounds. However, they display a remarkable spectrum of clinically useful biological properties. Unlike the development of new drugs, where extensive laboratory and animal testing must be done before they are used in humans, noble gases have exhibited some important medical effects in animals and humans before the basic biology of how they work has been studied. Despite this relative lack of knowledge of their mode of action, some of the noble gases have even been used successfully in the clinic.

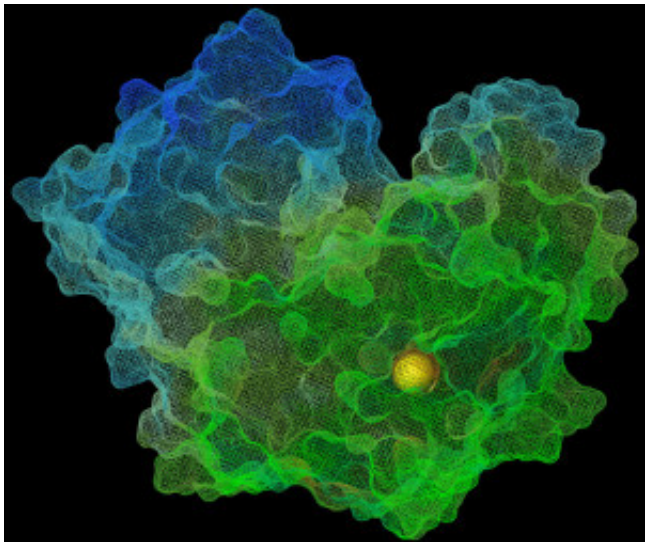

Fig. 1. Picture of a protein (represented by a mesh surface) showing binding of xenon (gold sphere) to the lipophilic (fat-loving) part of the protein (brown mesh). The blue mesh represents the parts of the protein that are hydrophilic (water-loving).

While most studies have involved xenon, as its atomic properties mean that it is taken up by the blood and organs better than the lighter noble gases, most noble gases are likely to exhibit valuable biological properties. These include almost ideal anaesthesia; reduction of cell and tissue damage after heart attacks and strokes; protection of organs prior to transplantation; analgesic (pain killing) properties; positive effects on addiction and memory; and a potentially wide range of other clinically useful effects. The gases appear to function by affecting proteins and lipid bilayers (walls of cellular compartments) because they are to a greater of lesser extent fat soluble (lipophilic). They will therefore bind to sites in proteins were the environment is similarly lipophilic (like dissolves like, see Figure) and can disrupt the binding of the natural signalling and other molecules that control protein function. Xenon has been shown to be safe in humans, and has other useful properties that mean it acts quickly and ‘washes out’ quickly once administration

stops.

The main things stopping its wider use in medicine are: that fundamental biochemical studies are still lacking; the lighter noble gases are likely to require hyperbaric (high pressure) conditions that are impractical in surgery; xenon is very expensive and administration using convectional anaesthesia equipment is inefficient, meaning its use s currently not cost-effective. This review provides an up-to-date summary of the extensive, useful biological properties of noble gases as drugs and prospects for wider application of these atoms.

David Alan Winkler
CSIRO Manufacturing, Bag 10 Clayton South MDC 3169, Australia
Monash Institute of Pharmaceutical Sciences, 392 Royal Parade, Australia
Latrobe Institute for Molecular Science, Science Dr, Australia
School of Chemical and Physical Sciences, Flinders University, Australia

Publication

The diverse biological properties of the chemically inert noble gases.
Winkler DA, Thornton A, Farjot G, Katz I.
Pharmacol Ther. 2016 Apr