

## Puzzles – suggested answers

### Suck it and see

The Russian version of this old belief, that drinking alcohol in small quantities enhances the effect drastically, says that nobody is capable of drinking 40 thimbles of vodka, though that amounts to only about 150 millilitres.

Michael Shusser, Caltech Pasadena California We decided that some preliminary research was needed, although of course we stress that no one should drink beyond safe limits (which means not at all if driving a car). To measure the effect of alcohol we adapted three police Standard Field Sobriety Tests, described to us by Wayne Jones of the National Laboratory of Forensic Toxicology in Linköping, Sweden. The tests were the number of times a subject stepped off a 3-metre- long straight line when asked to walk along it and back, the time each person could stand on one leg with his or her eyes closed, and the number of errors made in five attempts to touch the tip of their nose with eyes closed. Ten volunteers came forward from the office for two evenings of tests. Beer was the preferred drink and all our volunteers performed worse if they consumed their alcohol through a straw, rather than swallowing it, with the number of seconds they could stand on one leg halving. These results are only suggestive, of course, as all subjects obviously knew when they were drinking through a straw and could simply have adjusted their expectations. If the effect is real, what is the explanation? It could be that drinking small quantities helps to mix in air which carries alcohol to the nasal cavity where it could be absorbed rapidly into the brain, or perhaps that a more even flow of alcohol boosts absorption efficiency. Only an objective study, perhaps recording blood alcohol levels, could begin to answer these questions.

### Pain in the leg

Muscles which ache more the second day after exercise are a common phenomenon, especially if the exercise was more strenuous than usual. The condition is known as delayed onset muscle soreness (more commonly abbreviated to DOMS) and is associated with damage, inflammation and elevated creatine kinase activity.

This delayed soreness should not be confused with the transient ache sometimes felt during a bout of strenuous exercise, which is caused by the build-up of lactic acid. With regular training, adaptations appear in the muscles which significantly reduce the severity of DOMS, which is why it is less common in people who exercise regularly.

The most common cause of DOMS is eccentric muscular work, which occurs when the muscle lengthens as it is being used. It might happen when you lower a weight or run downhill.

Steve Bird, Department of Sport Science Canterbury Christ Church University College, Kent

### Five live

Human remote tassel-finned or fringe-finned (crossopterygian) ancestors emerged from the water with a limb architecture of one bone from the shoulder or hip, two

bones from the elbow or knee, and several bones from the wrist or ankle. All land vertebrates' limbs are based on that original scheme, including humans'.

These pioneers had lots of slender 'toes' on all four feet - too many and too slender for control and power. There must have been strong selection for a more definite joint structure and more strength in each digit. By the time the first true amphibians appeared, toes had thickened and been reduced to eight or so on each foot. Long before the first reptiles evolved, five toes had become pretty much standard issue. Mammals continued the pattern, which seems to be so robust and versatile that it has persisted among most nonspecialised groups and a good few specialists as well, such as tree climbers and their descendants, including humans.

Specialisation tends to reduce the number of toes. Creatures that run, for example, need light feet more than they need versatile bone architecture, so their toes reduce in number--down to one in horses--and in size--two main toes and a couple of vestigial ones in Artiodactyls: cattle, deer and suchlike. Some creatures, such as snakes, have even lost entire limbs. The only example of an added toe that I can think of is the giant panda's "thumb", which is, of course, not really a toe.  
Jon Richfield, Dennesig South Africa

### **Flat-footed**

Human feet have evolved to carry us comfortably across natural terrain such as grasslands and forest floors. These surfaces are usually inherently padded, and therefore each step taken does not jolt the body too much.

One of the by-products of civilisation is that the surfaces we walk on have become increasingly harder, to make them less prone to cracking under heavier loads such as the increased amount of traffic and to stop paths becoming impossibly muddy in winter, and so on. This, in turn, has meant that surfaces have lost the natural padding they once had. Because civilisation is a relatively new phenomenon, our bodies haven't had time to adapt directly. To compensate for this, we wear padded footwear. The heel is padded more than the toe simply because this is the area that strikes the ground with most force and therefore needs the most help.

### **Bodily breeding**

The microorganisms that inhabit the body of a healthy human being are known as the normal microbial fauna and they come in two different types - those that are permanently resident and those that are transient. Of course, any number of fascinating and nasty parasites can join this microbial community and make the human body their home.

In his seminal work **Life on Man** (Secker & Warburg, 1969), bacteriologist Theodor Rosebury gives a full biological and historical account of the microbes that live on the average human. The numbers involved are huge - Rosebury tells us: "If we are to get to the microscopic centre of this with our eyes open and our stomachs steady we might do better to look gingerly and sip instead of gulping . . . the life on man consists of microbes in extraordinary variety and large numbers."

The figures that he grapples with are quite mind-boggling. For example, he counted 80 distinguishable species living in the mouth alone and estimated that the total

number of bacteria excreted each day by an adult to ranges from 100 billion to 100 trillion. From this figure it can be estimated that the microbial density on a square centimetre of human bowel is around 10 billion organisms.

Microbes inhabit every surface of a healthy adult human that is exposed to the outside, such as the skin, or that is accessible from the outside - the intestines, from mouth to anus, plus eyes, ears and airways.

Rosebury estimates that 10 million individual bacteria live on the average square centimetre of human skin, describing the surface of the body as akin to a "teeming human population during Christmas shopping".

However, this figure can vary widely throughout the almost 2 square metres that make up the surface area of a human. In the oily skin that is found on the side of the nose or in a sweaty armpit, the figure can increase tenfold, while once inside the body, on the surface of the teeth, throat or alimentary tract, these concentrations can increase a thousandfold. These inside surfaces are the most densely populated region of the human body.

Conversely, on those surfaces where there is liquid flow removing bacteria, such as the tear duct or genito-urinary surfaces, the populations of organisms are much thinner. Indeed, Rosebury could detect no microbial life at all in the bladder and lower reaches of the lungs.

Yet, while the figures appear huge, he estimates that all the bacteria living on the external surface of a human would fit into a medium-sized pea, while all those on the inside would fill a vessel with a capacity of a mere 300 millilitres.

These figures increase if disease organisms are present, such as a virus or other infection, but not by any significant amount. While the total number of organisms living on us is huge, when one considers the volume of the human body, the volume of species using us as home is not so great.

As to the total number of species that are inhabiting a healthy body, estimates vary as more species are discovered on a seemingly regular basis, but Mark Pallen, a professor of microbiology based at the Queen's University of Belfast, reckons that the figure is in excess of 200.

## **Pointless**

Many suggestions for this phenomenon have been offered. They may exist to help men check that their vests are on straight, or be present as a safety feature - to warn us how far out from the beach we can safely wade.

However, there is a more plausible explanation. Male and female human embryos are identical in the early stages of their development. If the fetus receives a Y chromosome from its father, a hormonal signal is produced: the labia fuse to form a scrotum, the gonads develop as testicles and a male results. Otherwise the 'default' female remains.

Various structures in the adult reflect the symmetry of male and female and their common embryonic source. Men have nipples because they have already begun to

develop when the "switch to male" signal is received. The development of breasts is halted in most, but not all, cases but the nipples are not reabsorbed.

### **Crinkle tips**

The tips of fingers and toes are covered by a tough, thick layer of skin which, when soaked for a prolonged period, absorbs water and expands. However, there is no room for this expansion on fingers and toes, so the skin buckles.

Your whole body does not become crinkled as the skin has a layer of waterproof keratin on the surface, preventing both water loss and uptake. On the hands and feet, especially at the toes and fingers, this layer of keratin is continually worn away by friction. Water can then penetrate these cells by osmosis and cause them to become turgid.

### **Night growth**

We are all indeed taller in the morning. There are two components to this. In the growing child, growth hormone is secreted in pulses overnight. This acts through several intermediary steps to cause lengthening of the bones at the end-plates (epiphyses). Accurate measurements of the forearm or lower leg using specialised apparatus or X-rays can record this night-time growth.

The most marked effect, however, which occurs even after growth has ceased, is caused by postural compression of the spine under the effect of gravity. This was recognised in medieval French folklore - it was common practice to apply for recruitment to the army first thing in the morning in order to appear taller. In 1724 Reverend Joseph Wasse from Aynho in Northamptonshire measured a loss of up to six tenths of an inch (15 millimetres) through the day. This was more marked in young and active labourers. He noticed that his horse showed no shrinkage from shoulder to hoof after a long gallop to Oxford and correctly assumed the shrinkage was due to compression of the intervertebral discs.

Modern height measurements which are part of a series to monitor growth are taken at the same time of day, when possible, and with a stretching force applied to the head to minimise the postural loss.

### **Itching power**

First, scratching removes the stimulus which caused the itching, usually something like an insect or a hair. Second, the action of scratching stimulates blood to flow to the site. This allows an immune response which can sometimes remove the cause of irritation. Third, if you scratch hard enough the pain of the scratching takes your mind off the less significant itch.

### **Sex secrets**

1. Baby girls are less susceptible to almost the whole range of childhood illnesses, although improvements in medical science this century have lessened the impact of this.

2. Young men, especially around age 17, die far more frequently in road, and, to some extent, other accidents. The mortality rates for boys in their late teens are nearly three times as high as those for girls of the same age, and the difference is due almost solely to road accidents.

3. Men spend more time out of the house and, in particular doing manual work, and so fall prey to industrial injuries more often, although the effect has decreased over the past century.

4. Men are more susceptible than women to heart attacks and other cardiovascular diseases. This is now the main cause of the mortality differential between the sexes.

Important general indicators of life expectancy are smoking, marital status and social class. Smokers die earlier and married people live longer than people who are single and divorced. At age 15, in England, those in the top social class can expect to live almost four years longer than those in the lowest social class.

Life expectancy figures show that women live longer than men in almost all regions of the world, with the differences being biggest in the industrialised nations. In the few small areas where men live longer than women, the difference is caused by a higher mortality rate among female infants and is linked to social systems that value male offspring over females.

The answers above show that many of the differences in life expectancy are caused by behaviour: young men take more risks, men have generally worked in more dangerous environments and they suffer more stress. Would the difference disappear if men adopted more similar lifestyles to women? We don't really know, but as some of the risk-taking behaviour of males is linked to a surge in male hormones at adolescence, it is interesting that there is evidence that eunuchs have slightly longer life expectancies than normal males.

Among higher animals, females generally live longer than males, although there are exceptions. In his recent book, **Time of Our Lives: the Science of Human Ageing**, (Weidenfeld & Nicolson, p 184), Tom Kirkwood points out that male wolves live at least as long as females. The reasons are not known.

A general evolutionary explanation for why females live longer than males might be as given in Geoffrey Watson's answer. If males lived longer, they would be unlikely to pass on more of their genes or sufficiently help to ensure the survival of those who carry their genes. Females might do the latter and so longer-lived females have been at a selective advantage. Or, as Kirkwood puts it, "In a mammal, the male's contribution to child raising is often much less than the female's. This makes the female intrinsically much less disposable than the male." This theory has not been tested, as far as we know.

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