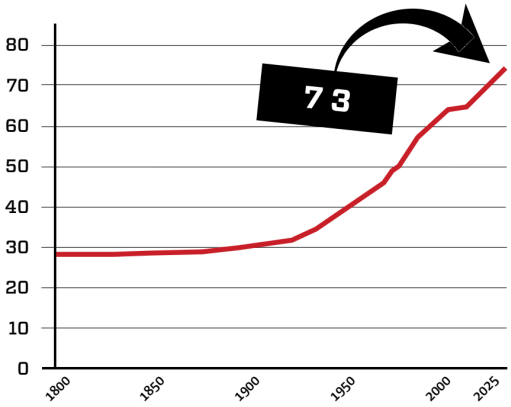
- Longevity / Ageing

We've extended our lifespan by 35 years in the last century. So:

COULD WE LIVE FOREVER?

If age is a disease, it can be cured, claim some researchers who believe that in addition to extending life through better health, there may be a fountain of youth available in our cells.





Over the past 100 years, average global life expectancy has roughly doubled. Today, it is approximately 73 years.

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By **Ebbe Rasch**

BIG SCIENCE SERIES

The 10 biggest scientific mysteries

LIVING FOREVER



Many babies born today are likely to live to 100 years old – allowing researchers more time to extend life even further.

SHUTTERSTOCK & MIKKEL SKOV BENEDIKTSON

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Cardiovascular disease, dementia, cancer: diseases claim millions of lives worldwide every year, and the underlying cause of death is often the same – and it is not smoking, an unhealthy diet, or lack of exercise. The killer is age. Twenty-year-olds rarely get cancer, and almost never dementia or blood clots. Only over time does the human body becomes poorer at maintaining itself and battling disease. We end up paying with our lives.

Around a million people have turned 100. Only one per thousand of them reached 110+.

122 years is the record

When *Homo sapiens* took its first steps, life expectancy for our species was 25-30 years, scientists estimate. And it stayed that way for millennia. Sky-high infant mortality rates and low medical knowledge kept life expectancy low.

The change has been astonishingly recent: only in the last century has life expectancy risen significantly through new medical advances – notably about microorganisms – and technological advances such as universal sewerage. Today, the global average is 72-73 years, though it is lower in Central Africa, higher in places such as Japan and Western Europe.

The increase is almost inconceivably dramatic: increasing lifespan by 40 years over the last century means that we have been increasing average life expectancy by 9.6 hours every single day.

A few outlying people have beaten even these remakable statistics. In 1997, Jeanne Calment of France died at the age of 122 years and 164 days – the longest life ever verified. As we go to press on this issue, the world's oldest person is Inah Canabarro Lucas from Brazil, who turned 116 on 8 June 2024.

The US government estimates that around one million people have so far turned 100. Only one in a thousand of them has reached 110 years old – and the vast majority are women.

Calment is the only person who has been verified to exceed 120 years old. Most people's body cells give up 30-40 years earlier. The body relies on cells to divide for a flow of fresh cells, but cell division has its



// AGEING BREAKS DOWN THE BODY

Cells are attacked on three fronts

Throughout life, your cells are replaced, and this keeps you healthy. But with age, the cells run out of energy and stop dividing, triggering a vicious cycle in which cells secrete harmful substances.

MASTER1305/SHUTTERSTOCK

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limits. Cells in the gastrointestinal tract last only a few days before they need to be replaced. Skin cells last a few weeks, while fat cells can last a decade.

Short chromosomes prevent cell division

The human body has 30-40 trillion cells, all of which (except red blood cells) contain a genetic formula in their DNA: long, twisted strands of base pairs.

To fit a 2-metre-long DNA strand into a cell which has a diameter of just 0.02mm, the strand is wrapped and folded around proteins (histones) in 46 bundles known as chromosomes.

At the ends of chromosomes are telomeres: a kind of 'cap' of base pairs that exists solely to protect chromosomes and prevent them 'clumping'.

But each time a cell divides and produces a new cell, the telomeres become a little shorter. Eventually, they are so short that the cell can no longer divide, and our source of new cells runs dry.

The first consequences of short telomeres are the visible outward signs of ageing: we may develop grey hair, or increasingly deep facial wrinkles.

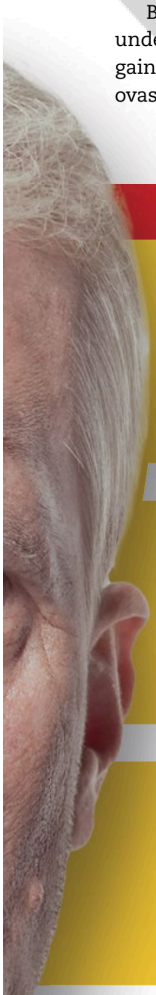
But more severe consequences are going on under the skin. The impaired cell division means we gain an increased risk of age-related disorders: cardiovascular disease, diabetes, various types of cancer.



LONGEVIQUEST/YOUTUBE

Japan's Tomiko Itooka turned 116 on 23 May 2024, and in September 2024 she became the world's oldest verified living person, remaining so until her death on 29 December 2024.

The immune system weakens, neurodegenerative risks increase for diseases such as Alzheimer's, as does inflammation in the body, increasing the likelihood of suffering from rheumatic diseases. In other words: it ▶



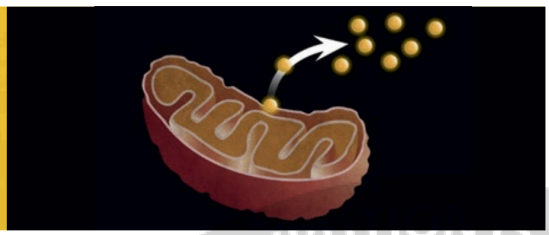
Weakened chromosomes halt cell division

1 Cell chromosomes contain the body's DNA (the genetic formula) and are protected by telomeres (red). With each cell division, telomeres shorten slightly. Eventually they are too short for the cell to be able to divide.



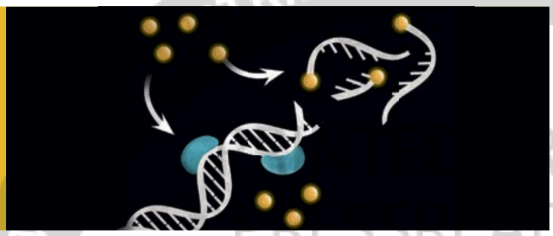
The power plants in our cells start to fail

2 Mitochondria generate and supply energy to all body cells. But with age, our mitochondria weaken, boosting the production of free radicals (yellow), which are harmful to the body in various ways.



Harmful substances destroy DNA

3 Normally the protein sirtuin (blue) protects cell DNA from attacks by free radicals (yellow), but the effect weakens with age. So in older people free radicals can destroy DNA, increasing the risk of cancer.



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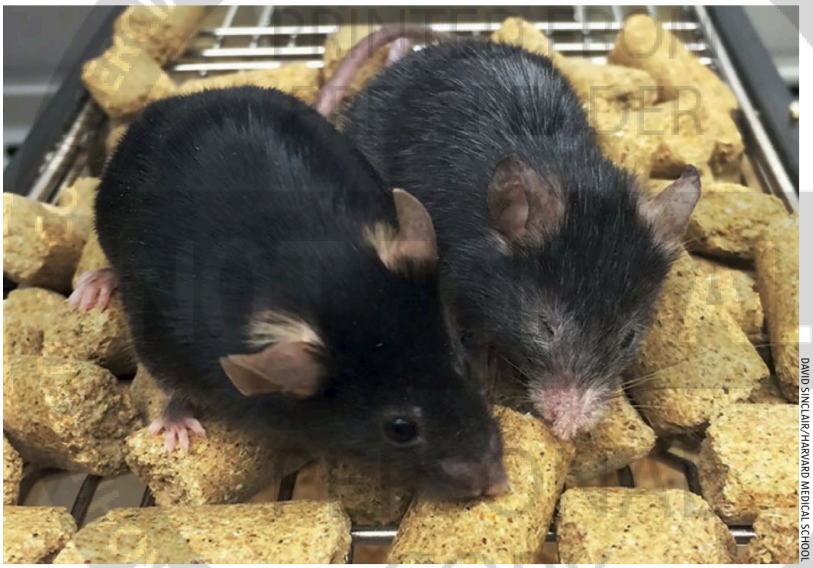

DAVID SINCLAIR/HARVARD MEDICAL SCHOOL

Same age, different age: US researchers used gene manipulation to make mice from the same litter grow old differently.

▶ is shortening telomeres at the end of our chromosomes that will eventually kill us, one way or another.

So it might seem that if we could somehow preserve these telomeres, we could slow ageing.

That is exactly what Liz Parrish of the US tried to do in 2015 – not in the lab, but in her own body. Parrish was injected with a modified gene that produces telomerase, an enzyme which lengthens telomeres. The gene therapy had been successfully tested on lab mice which then had their ageing delayed. And like the mice, Parrish's telomeres also became longer.

Cancer cells abuse telomerase to divide out of control. If cell division is left unchecked, the disease is given free rein.

She claimed that the treatment did make her feel younger. But the scientific evidence is that the treatment had only a small effect, while the telomere lengthening may come at a high price that Parrish has not yet paid: an increased risk of cancer (as of a health check in October 2024, she claims to remain perfectly healthy).

But many cancers do abuse telomerase to divide out of control. If cell division is left unchecked, the disease is given free rein to spread – and that is worse than ageing. The link between cancer and telomerase has made other doctors search for a method that can lengthen telomeres without such side effects.

But researchers are also looking for an ageing cure in mitochondria – the powerhouses of cells. As we age, the mitochondria weaken and so leak large quantities of free radicals into cells.

These can break down proteins in cells, fat in cell membranes, and DNA itself. Cells have various defence mechanisms against free radicals, but the mechanisms do not function properly in ageing cells.

So doctors are researching ways to slow the process, such as with resveratrol. Resveratrol exists in berries, grapes, and dark chocolate, an antioxidant that can combat free radicals, at least in lab animals. The results of clinical trials in humans are not yet conclusive – although it sounds tantalisingly as if chocolate and grapes might prolong life.

Researchers are looking deep into genes

The other way to extend life may be to 'cheat'. If telomeres and antioxidants have so far failed to deliver quantifiable advances, scientists can always turn to CRISPR gene technology, which in recent years has made it possible to edit body genes – and so, in theory at least, reverse some age-related changes.

If ageing cells struggle with damage to mitochondrial DNA (mtDNA), CRISPR could correct the damage to make the power plants as good as new.

Another promising field is stem-cell research. In an unborn baby, all cells are stem cells that can develop into the specialised cells found in the adult body – intestinal cells, skin cells, nerve cells, and so on. This ability of stem cells disappears as the body grows, but in 2006 Japanese scientist Shinya Yamanaka found a way to transform ordinary skin cells into universal stem cells that can once again become all types of specialised cells.

Yamanaka's induced pluripotent stem cells (IPS cells) could be a future elixir of youth. If ageing liver cells with worn-out telomeres and mitochondria can be supplied with fresh new IPS cells, the liver might regain its youthful vigour.

And if all worn-out cells can be replaced by new ones, the body could – in theory – live forever.

In 2023, researchers from the prestigious Harvard Medical School in the US showed that manipulating genes can affect ageing in mice. But clinical trials in humans are a long way off. And researchers face a challenge inherent in all ageing research: the trials take a really long time. If doctors need to determine with certainty whether a newborn can live for 120 years, the trial is going to take at least 120 years.

But while ageing cannot be completely cured immediately, there is certainly hope for a longer life. The statistics speak for themselves. If an infant today chooses a healthy lifestyle, the baby can look forward to living 100 years. That gives researchers another century to find cures that can delay age-related diseases... and hence ensure that that child may live to, say, its 150th birthday. Which leaves another 50 years to again postpone death. In other words: if you live long enough, life may be extended indefinitely. SI

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// THE WORLD'S OLDEST ORGANISMS

Old inhabitants of Planet Earth

We've done well – the human lifespan record of 122 years far exceeds what you would expect from human-sized mammals. But there are even more impressive age records elsewhere in nature, such as a blind rat living 10 times as long as its closest relatives, and a jellyfish that may effectively live forever.

AGE

30 YEARS

Wrinkled rat is the Methuselah of rodents

Small rodents such as hamsters, mice and rats usually live for only 1-2 years, but the blind naked mole-rat lives underground for up to 30 years – longer than any other rodent.



KATERYNA KON/SHUTTERSTOCK

192 YEARS

Tortoise has survived 36 human owners

In 1882, the governor of the Atlantic island of St Helena was given a 50-year-old Aldabra tortoise. It is still alive – now with its 36th owner. Several such tortoises have turned 150.



YURI KRAVCHENKO/SHUTTERSTOCK

512 YEARS

Arctic shark holds vertebrate age record

In 2016, analyses of a Greenland shark eye showed that the animal had lived for up to 512 years, making the shark, which grows up to 5 metres long, the longest living vertebrate on the planet.



DOTTED YETI/SHUTTERSTOCK

5000 YEARS

Modest pine trees are older than the pyramids

In the White Mountains of SW USA, the western bristlecone pine tree includes individuals almost 5000 years old. A clonal Huon pine 'stand' in Tasmania may qualify as one of Earth's oldest living clonal organisms at 10,500 years.

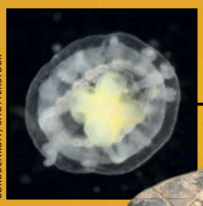


HERSCHEL HOFMEYER/SHUTTERSTOCK

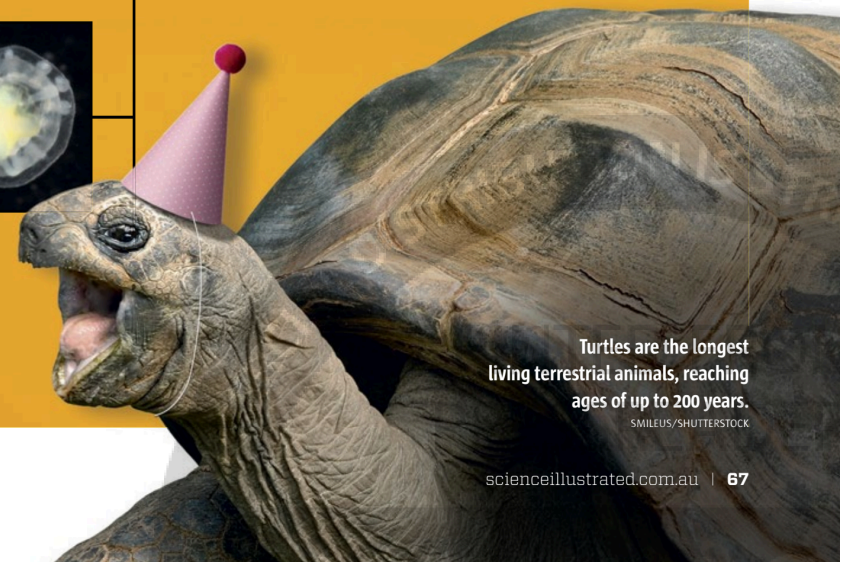
ETERNAL LIFE?

Old jellyfish can start over again

The jellyfish *Turritopsis dohrnii* grows old after a few months, but knows a special trick: it returns to the polyp stage and starts life all over again. The process can be repeated, perhaps indefinitely.



GORODENKOFF/SHUTTERSTOCK



TSVPHOTO/SHUTTERSTOCK

Turtles are the longest living terrestrial animals, reaching ages of up to 200 years.
SMILEUS/SHUTTERSTOCK

You and I are gonna live forever...

Oasis may have overstated present longevity in their song 'Live Forever', but science has plenty of suggestions on how to extend a healthy life through sleep, friends, and becoming wealthy.

ROMAN SAMBORSKYI/SHUTTERSTOCK

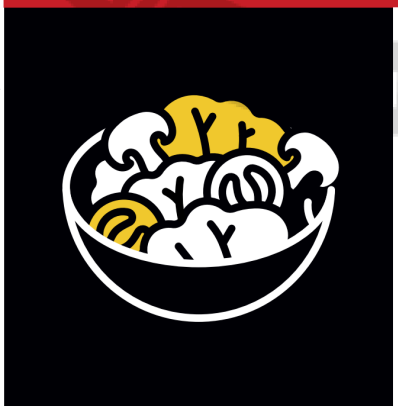


HOW CAN YOU PROLONG YOUR LIFESPAN?

EAT HEALTHY FOOD

YOUR DIET SHOULD BE HEALTHY – AND MODEST

MENTALMIND/SHUTTERSSTOCK



Most of us know perfectly well that there is a link between diet and health. Consuming foods high in unhealthy fats, sugar and salt while avoiding dietary fibres will increase risk of cardiovascular disease, type 2 diabetes, certain cancers, and obesity, any of which could kill you.

A major Norwegian study published in 2023 demonstrated that a healthy diet can extend life by up to 10 years.

But it may pay to cut back on eating, even if your diet is healthy. Calorie restriction (reduced energy intake) seems to help the body stay young. The explanation is believed to be 'hormesis': when the body is exposed to a small but stressful situation, such as being hungry, it becomes better at coping with similar situations in the long term. The phenomenon is not yet fully understood, but some ageing researchers recommend fasting for short periods of time – a few days a month – because it may boost body cells via hormesis and extend your life. But fasting itself can cause problems, so do discuss this with a G.P. before trying it.

SWEET DREAMS

SLEEP YOUR WAY TO A LONGER LIFE

MENTALMIND/SHUTTERSSTOCK



A shortcut to a longer life that most people can manage is more sleep. The price is fewer active hours, but a beneficial sleep rhythm can add years to your life.

A good night's sleep is important for the repair and rebuilding of cells, muscles, and tissues – and sleep plays a role in the regulation of telomere length. Worn-down telomeres is almost a definition of ageing, slowing cell division in the body, causing increased risk of disease. The immune system also relies on the body shutting down for a few hours every night, and a weakened immune system can make the body more susceptible to infections and inflammations which affect life expectancy.

Researchers have also found that too poor or too little sleep increases the risk of neurodegenerative conditions such as Alzheimer's. Dementia itself is not fatal, but it is life-shortening, because it can cause many secondary complications. Sleep requirements are individual and age-dependent. School children need 8-12 hours a day, while 7-9 hours is usually enough for adults.

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EXERCISE

A HIGH PULSE RATE BOOSTS MITOCHONDRIA



ICONIC SPACE/SHUTTERSTOCK

Every day, many smartphones remind users to walk 10,000 steps. It's become a near universal recommendation, but the number was chosen by Japanese health science professor Yoshiro Hatano in the 1960s simply because "10,000 steps was a nice number". The 'manpo-kei' 10,000 step rule became a huge success in Japan both as a concept, and as a pedometer.

Research has since shown that Hatano was about right. According to a major study published in *The Lancet*, body weight, blood pressure and the risk of cardiovascular disease all decrease if adults walk 7000-8000 steps a day. In the long term, it also strengthens bones and prevents osteoporosis. But even a person who walks 4000 steps a day, and does so every day, will stay healthy.

Strenuous physical exercise involves particular benefits, including stimulating formation of mitochondria – the powerhouses of cells, the efficiency of which decreases with age. Exercise causes an energy deficit in cells, which respond by producing new mitochondria.

MAKE FRIENDS

SOCIAL CONTACT KEEPS BRAIN & BODY HEALTHY



ANNA_DESIGN/SHUTTERSTOCK

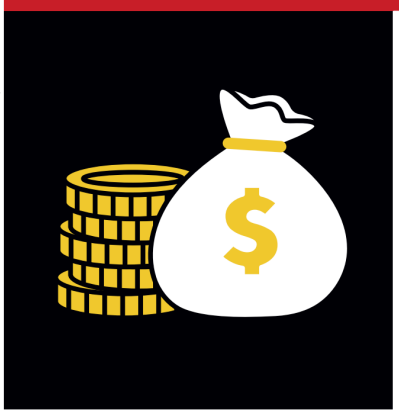
When our earliest ancestors started to walk upright, they were 'herd animals'. Today it is possible to live all alone, but it is not a good idea. Research has demonstrated clearly that strong bonds with good friends and an active social life are beneficial to both mental and physical health. According to a US study, loneliness is more life-shortening than smoking and obesity.

Social contact contributes to prolonging life in several ways: it reduces stress and anxiety that otherwise lead to the risk of blood clots and alcohol abuse, which further shorten life. One research group demonstrated that social contact increases the likelihood of being physically active, which is good for the body, while the brain also benefits from friendships. Social relationships help keep it sharp and so delay cognitive decline such as dementia.

In practical terms, social contact also increases the likelihood of any disease being treated in a timely manner, simply because friends will notice and alert you if you develop a new health problem.

GET RICH

WEALTH BRINGS BETTER CARE, FEWER WORRIES



MENTALMIND/SHUTTERSTOCK

Money is not everything, but it can give you a long and healthy life, particular as free health care becomes more difficult to access. The logic is obvious: if you can afford to see a doctor, you are less likely to die from disease. A study from the US – the wealthiest nation in the world – has shown that men in the wealthiest 1% of the population live averagely 14.6 years longer than the poorest 1% of men. For women the gap is 10.1 years. Yet the study also concluded that the difference in life expectancy was due not so much to differences in access to doctors and hospitals, but because the wealthier group had fewer smokers and a generally healthier lifestyle.

Another study from Harvard Business School found the wealthy less susceptible to stress, which can lead to type 2 diabetes and cardiovascular disease. While the wealthy experience as many frustrations as their poorer counterparts, they tend to take the worries less stressfully, leading to a generally higher level of satisfaction, and a longer life.

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