LONG LIFE AND GOOD HEALTH

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GO FOR THE BURN

How's this for an elixir of youth: an X-ray, a mild case of sunburn, a couple of beers and a sauna. If you think all that would leave you feeling anything but youthful, think again. Many researchers believe that small doses of "stressors" such as poisons, radiation and heat can actually be good for you - so good that they can even reverse the ageing process. This counter-intuitive effect, called "hormesis", was once considered flaky, but in recent years it has been shown to extend longevity in yeast, fruit flies, protozoans, worms and rodents. If the findings extend to people, it could stretch the average healthy human lifespan to 90, says biologist Joan Smith-Sonneborn of the University of Wyoming in Laramie.

How so? Stressors seem to kick-start natural repair mechanisms, including heat-shock proteins and DNA-repair enzymes, to fix the damage they have caused. If this damage is not too severe, the repair systems may overcompensate, building up enough oomph to repair unrelated damage as well. And if you accept the idea that damage equals ageing, this is nothing less than rejuvenation.

There is already some indirect evidence that hormesis has positive effects on human longevity. Between 1980 and 1988, researches at Johns Hopkins University in Baltimore, Maryland, tracked 28,000 nuclear shipyard workers to study the effects of low doses of radiation. To their surprise, they found that the mortality rate of these workers was 24 percent lower than in a control group of 32,500 shipyard workers of similar ages who were not exposed to radiation.

An earlier study by legendary epidemiologist Richard Doll found similar low death rates among radiologists, compared with other doctors. Perhaps most strikingly, Barbara Gilchrest of Boston University has shown that feeding fragments of DNA to elderly human cells grown in culture, which mimics the effect of DNA damage, restores their DNA repair capabilities to levels usually seen only in youthful cells.

You may not even have to expose yourself to poisonous chemicals or radiation to see the benefits of hormesis. An increasing number of gerontologists think caloric restriction - the near-starvation diet that is the only reliable way so far of increasing lifespan in animals - works because it is a low-level stressor. Better yet, some compounds with supposed anti-ageing properties, notably vitamin E and melatonin, seem to act hormetically in protozoans: increasing longevity when taken in small amounts but not large ones.

The big unanswered question is at what dose does an otherwise harmful agent become beneficial.

Clearly, too much radiation or poison are bad for you. However, there may be a safe way to trick your body's repair mechanisms into overdrive. Smith-Sonneborn and others suspect that the life-extending effects of exercise are also down to hormesis. She proudly practices what she preaches with an exercise regime that she says stresses her body to just the right level to get the optimum response. "I'm 70 and I have the bone density of a 35-year-old, " she says.

DON'T BE A LONER

Being sociable looks like one of the best ways to add years to your life. Relationships with family, friends, neighbors, even pets, will all do the trick, but the biggest longevity boost seems to come from marriage or an equivalent significant-other relationship. The effect was first noted in 1858 by William Farr, the British founding father of demography, when he penned (with quill) that widows and widowers were at a much higher risk of dying than their married peers. Large statistical studies carried out since then suggest that marriage could add as much as seven years to a man's life and two years to a woman's. The effect holds for all causes of death, whether through illness, accident or self-harm.

Even if the odds are stacked against you, marriage can more than compensate. Linda Waite of the University of Chicago has found that a married older man with heart disease can expect to live nearly four years longer than an unmarried man with a healthy heart. Likewise, a married man who smokes more than a pack a day is likely to live as long as a divorced man who does not smoke. There is a flip side, however, as partners are more likely to become ill or die in the couple of years following their spouse's death or hospitalization, and caring for a spouse with dementia can leave you with some of the same severe cognitive problems, largely because of disturbed sleep patterns. Even so, the odds favor marriage. What's more, in a 30-year study of more than 10,000 people, Nicholas Christakis of Harvard Medical School describes how all kinds of social networks have similar effects.

So how does it work? The effects are complex, affected by socio-economic factors, health-service provision, information distribution, emotional support and other more physiological mechanisms. For example, social contact can boost development of the brain and immune system, leading to more robust health and less chance of depression later in life. People in supportive relationships may handle stress better. Then there are the psychological benefits of a supportive, kindly partner. Elderly people who hear loving positive words are more sprightly in step and less likely to request a "do not resuscitate" instruction when admitted to the hospital than those who hear negative comments.

A life partner, children and good friends are all recommended if you aim to live to 100. The ultimate social network is still being mapped out, but as Christakis says: "people are interconnected so their health is interconnected".

CONSIDER RELOCATION

The world is dotted with longevity hot spots where the number of centenarians exceeds 10 in 100,000. But why? Perhaps the locals are genetically primed for longevity. It could be something in the water. Or it may simply be that these are statistical flukes - places where oldies outnumber youngsters, so increasing the proportion likely to pass the 100 mark. Whatever the reason, the very existence of hot spots raises the question of what sort of environment is most conducive to a long life.

While small doses of radiation and toxins can be beneficial, a neighborhood humming with either is an obvious no-no. There are also some more subtle environmental influences you should avoid if you want to live long and prosper. A recent study of elderly residents from a poor area of St. Louis, Missouri, found that factors such as low air quality and dirty streets tripled the likelihood of their suffering from disabilities in later life. Likewise, a survey by Scottish newspaper *The Scotsman* in January found that people living in the poorest suburbs of Glasgow had a life expectancy of just 54 - three decades shorter than people in wealthier areas.

Still, teasing out the various factors at play here is tricky to say the least, and there are wildly differing views about whether it is our physical environment or our genetic make-up that contributes most to longevity. S. Jay Olshansky of the University of Illinois in Chicago is among those who put the emphasis on genes, but even this camp accepts that environment can affect the potential lifespan we are born with. We eat the wrong foods, drink, smoke, expose ourselves to the sun, Olshansky says. "All of that shortens our lifespan".

Tom Perls, who heads the New England Centenarian Study at Boston University, represents the other end of the spectrum. He believes that while longevity may seem to run in families, environment accounts for up to 70 percent of this effect. "Just because it's familial doesn't mean it's all down to genes," he says, because family members often share many environmental factors. He points to a group of Seventh Day Adventists in California whose lifespan averages 88, a decade more than the US average. They are genetically quite diverse, but share a lifestyle that includes vegetarianism, no smoking, no drinking and with strong emphasis on family and religion, all of which can contribute to longevity.

There is general agreement, however, that your physical location is less important than the personal environment you create through your behavior. You could up sticks and move to the Japanese island of Okinawa, the world's number one longevity hot spot, but a better bet might be to live life the Okinawa way. "We boil it all down to four factors: diet, exercise, psycho-spiritual and social," says Bradley Wilcox, a researcher with the Okinawa Centenarian Study.

MAKE A VIRTUE OUT OF A VICE

One of the most informative studies of healthy ageing to date has been conducted at the convent

of the School Sisters of Notre Dame in Mankato, Minnesota. The nuns there, around 1 in 10 of whom have reached their hundredth birthday, teach us that a healthy old age is often a virtuous one - which means no drinking or smoking, eating healthily an din moderation, and living quietly, harmoniously and spiritually. But clean living is not to everyone's taste. Besides, what is the point of living to 100 if you can't enjoy a few wicked indulgences? Assuming you will have some vices, the trick is to choose them wisely.

The idea that one glass of wine a day is actually good for you in now ingrained in the popular consciousness. Some say that wine is what underlies the "French paradox", the unexpectedly low rate of heart disease in the Mediterranean population. Wine does contain fruit antioxidants, but many of these chemicals are also found in the raw fruit. Beer too has its health lobby. The research literature is rather at a loss to explain these effects, or even to agree that they exist. While the issue is still in doubt, however, is it worth the risk of not drinking?

Another vice that you probably shouldn't fight too hard is sleep. If you love your duvet, sleep easier knowing the findings of Till Roenneberg of the University of Munich in Germany. He showed that unless you can reset your body clock with lots of bright light and good discipline, fighting your natural lark or owl tendencies can be bad for your health.

Then there's chocolate. It contains compounds called flavanoids that have been found to lower blood pressure and possibly even reduce your risk of suffering a stroke. The latest research suggests they do this by enhancing the body's production of nitric oxide, which dilates blood vessels, relaxes arteries and enhances blood flow. Chocoholics should be aware that not all candy bars are chock full of flavanoids. Your best bet is dark chocolate, but the choice is set to expand as the big confectionary manufacturers capitalize on the life-enhancing qualities of their products and start to produce special flavanoid-rich bars.

Whatever your pleasure, the great news is that pleasure itself is good for you. Really good. Not only does it counteract stress, it also causes our cells to release a natural antibiotic called enkelytin. Whether it's chocolate, coffee, having a tipple or a flutter, a spot of sunbathing (with suncream), a romantic (or more carnal) encounter, or another form of sinful pleasure, think of it as self-medication. Just make sure that if you have a vice, you enjoy it.

EXERCISE THE LITTLE GREY CELLS

Your best shot at living out a century with an active enough mind to know about it is probably to become a nun. Not only are there many centenarians among the Minnesota nuns studied by

David Snowdon of the Sanders-Brown Center on Aging at the University of Kentucky in Lexington, but some of them also seem very resilient to the effects of Alzheimer's disease and other forms of dementia.

Not prepared to take holy orders for the sake of your continuing mental health? Then you had better be smart in the first place. By our mid twenties, our mental faculties have already reached their peak in terms of reasoning, spatial awareness and memory. After that, things start to decline. The best way to get around this is to start with some excess capacity. Study after study has shown that intelligence, good education, literacy and high-status jobs all seem to protect people from the mental ravages of old age and provide some resistance to the symptoms, if not the brain shrinkage, of dementia. Brain researchers and doctors are starting to refer to it as brain or cognitive reserve.

Some think the effect is simply about having a long way to fall. Others suspect it is more about greater mental efficiency or having alternative options and back-up plans for solving any given problem. Either way, cognitive reserve is a hot research area right now. It seems that boosting your mental capacity might have as potent an effect as the drugs that are already available for dementia. Better yet, it is never too late to begin your cognitive workout. Mental gymnastics are definitely on the agenda - everything from reading to learning new things to interacting with people rather than being a couch potato. But don't stop with mental exercises. At least one study has shown that older mice produced new brain cells faster and learned quicker than sedentary creatures when they were put on an exercise program.

All this helps explain the remarkable mental health of those centenarian nuns, who fill their advancing years with both physical and mental activity, from gardening and crosswords to reading, walking, conversation and knitting.

SMILE

Centenarians have surprisingly little in common, but one thing most do share is their love of a laugh. "These people are gregarious and fun to be with," says Tom Perls from the New England Centenarian Study. He reckons the key is how they respond to stress. Although a little stress may be good for you, sustained and severe stress can cut your life expectancy. Perls suspects that people born with a sunny disposition cope better with stress, which increases their changes of reaching a ripe old age.

Evidence is mounting in his favor. The study of nuns in Minnesota reveals that those who had the most positive outlook on life during adolescence and young adulthood are also the healthiest in old age. Optimism improves the prospects of patients with heart conditions, and it increases your chances of recovering from infectious diseases. A positive attitude can also help stave off the ravages of time. Earlier this year, researchers from the Institute of Mental Health in Delft,

the Netherlands, reported that older men with an optimistic outlook on life were only half as likely to suffer from cardiovascular disease over a 15-year period as those whose worldwide view was more negative, regardless of their initial state of health. In another new study researchers from Yale University found that over-70s who held negative stereotypes of the elderly were more likely to suffer hearing loss over a three-year period than those who saw oldies in a more positive light. Hearing loss, which can be very isolating, is the third most common chronic condition among the over-65s.

What seems to be happening, explains Janet Lord of the University of Birmingham, UK, is that positive thinking lowers levels of the stress hormone cortisol, which dampens the immune system. Its effects are offset by another hormone called DHEA, but levels of DHEA start to decline from around the age of 30, dropping less than 20 percent of their maximum value by the time we reach 70. That, she says, is why we gradually become less able to fight off diseases as we age. In addition, cortisol has adverse effects on the cardiovascular system and the brain. A new study from the University of Edinburgh, UK, for example, reveals that older men with high levels of cortisol have smaller anterior cingulate cortices. Shrinkage of this brain region is linked with Alzheimer's disease and depression in older people, and the researchers think it may be caused by stress.

Some people are born laid-back, but even if you are a natural stress bunny, there are things you can do to reduce your cortisol levels. "These include t-ai chi, exercise, having faith, meditation and yoga," says Perls. "Even a deep breath can reboot you." He cites the "relaxation response", devised three decades ago by Herbert Benson of Harvard Medical School and founder of the Mind / Body Medical Institute in Chestnut Hill, Massachusetts. It couldn't be simpler. Just sit comfortably, close your eyes and listen to your breathing. On each outward breath, repeat a calming word, sound or phrase and gently rid your mind of any intrusive thoughts. For best results, repeat each morning for 10 to 20 minutes. Benson describes the effects as "the physiological opposite of stress", and uses it to treat a variety of conditions, including depression, high blood pressure and insomnia.

Relaxation is all well and good, but there is an even more enjoyable way to achieve similar results. Those happy centenarians have it figured out. It turns out that laughing and smiling also reduce cortisol levels. A happier life is likely to be a longer one - and that's surely something to smile about.

NURTURE YOUR INNER HYPOCHONDRIAC

One obvious piece of advice form anyone wishing to become a healthy centenarian is this: if you're sick, go see a doctor. But what if you are ill and don't know it? Lots of life-threatening diseases have innocuous beginnings, and some remain symptom-free until it is too late. Clearly, it can pay to anticipate the worst. So, what are the most effective preventative measures to take

and when should you take them?

Those searching for an early warning system will find a bewildering range of options. A few hundred dollars buys you a full-body CT scan, capable of spotting silent tumors or early signs of heart disease. Numerous cancers and diseases such as diabetes can be picked up early with other simple tests. Meanwhile, genetic screens can tell you whether you have an elevated risk of developing, say, breast cancer, so that you can be extra vigilant.

At first glance these all look like must-haves. The tests either tell you you're as fit as a fiddle, or alert you to a problem you didn't know was there. Win-win. Unfortunately, it is not as simple as that.

Take prostate cancer. Across the world, millions of middle-aged men regularly have blood tests for high levels of an antibody called, PSA which can indicate prostate cancer. The test has undoubtedly saved thousands of lives, but it is no guarantee. Many men with prostate cancer do not have high PSA, and two out of three men with an elevated score do not have cancer. What's more, even if the test does find cancer, treating it can sometimes do more harm than good, as most prostate cancers are so slow-growing that they wouldn't be fatal even to a man who lived to 150.

The PSA test is notoriously problematic, but most screening techniques suffer similar drawbacks. First, there is always a risk of false positives, leading to psychological stress and unnecessary medical intervention. If the false positives don't get you, the false negatives might: a clean test result might mean you rest too easy and ignore real symptoms. Sometimes the screens themselves are bad for you. A full-body CT scan, for example, delivers a dose of radiation equivalent to 500 chest x-rays. A single scan won't do any significant damage but if you go for one every couple of years you may be taking an undue risk. Perhaps worst of all, there may be times when the tests find something, yet there is nothing that can be done for you.

Which prophylactic measures are worth it, then? There is no easy answer. In the UK, the National Health Service will only pay for screens that have passed 19 strict tests of risk versus benefit. That has narrowed the field to just a few types of screening: bowel cancer for 60 to 69-year-olds; mammograms for women aged 50 to 70; cervical screening for women aged 25 to 64. The NHS also advises people to self-examine their breasts or testes for lumps and is considering screening overweight and obese people for diabetes. Anyone with a family history of breast or colon cancer can request a genetic test to see whether they have inherited a risky gene, and doctors will perform PSA tests after counseling.
Beyond that, it's a case of you pays your money and you takes your pick, but do seek professional advice. In other words, go see a doctor.

WATCH WHAT YOU EAT

There's good news and bad news for anyone who wants to eat their way to 100. The good news

is that you may be able to do it. The bad news is that there won't be much eating involved. The only proven strategy to extend lifespan is caloric restriction - deliberately eating just enough to get by. This extends the lives of mice by about 30 percent, and if humans enjoyed the same boost that would be enough to nudge life expectancy past the century mark.

Is it worth the deprivation? A growing number of people think so, and new evidence suggests that skimping on the doughnuts could indeed help you pile on the years. In April, researchers reported that people who ate 25 percent less than usual for three months had lower levels of insulin in their blood, a lower body temperature and less DNA damage, all of which are generally associated with longevity. No one knows yet whether the benefit is lasting: longer-term studies are under way but, for obvious reasons, we are unlikely ever to have the gold-standard experiment in which people are randomly assigned to normal or restricted diets to see which group lives longest.

On the other hand, skeptics such as Lloyd Demetrius of Harvard University doubt that caloric restriction would extend your lifespan by any more than a year or two at best. While many people think the diet works by lowering an individual's metabolic rate is and so reducing the production of damaging free radicals, he believes that metabolic stability is the key to ageing. This, he argues, is why cutting calories is unlikely to have much effect in humans. Animals such as mice that have evolved to cope with feast and famine environments have highly fluctuating metabolisms, and can benefit from caloric restriction, but our metabolic rate is already stable.

Even if you don't live longer, constant hunger will probably make life feel longer. If that thought doesn't appear, perhaps the best alternative is to follow the advice of your old nanny - or at least the nanny state. The UK Department of Health is pushing harder than ever for Britons to eat up their five portions a day of fruit and veg, following research carried out on its behalf recently which found that this increases longevity by three years. The theory is that foods high in antioxidants, such as vitamins C and E and beta-carotene, delay ageing by mopping up free radicals. Unfortunately other evidence on the effect is equivocal, but that may be because the experiments used antioxidant supplements rather than real foods. Meanwhile, there is stronger evidence supporting the assertion that fresh fruit and vegetables - especially greens - help keep ageing brains sharp.

If this all sounds too insubstantial to warrant a change in your eating habits, consider two facts: studies of centenarians make it clear that a healthy diet is an extremely important factor in longevity, and eating high-calorie, fat-laden foods is one of the surest ways to an early grave.

GET A LIFE

So, you're well on your way to reaching the bid one-zero-zero. How are you going to make the most of those extra years? What you need is a bit of excitement along the way. Take some risks. Not only will new experiences bring you pleasure, you may also find they have added benefits.

For a start, a novel intellectual challenge will keep your mind sharp and could also ward off

diseases. Marian Diamond of the University of California, Berkely, has found that playing bridge boosts the immune system. Her studies with lab rats even suggest that intellectual novelty promotes longevity: rodents given mazes to solve and toys to play with lived 50 percent longer. There is also plenty of evidence to indicate that the kind of buzz you get from traveling, learning a new language, completing a sudoku puzzle or creating your own artistic masterpiece helps delay the onset of neurodegenerative diseases, including Alzheimer's.

If that seems a bit tame, what about the excitement of an adventure sport - after all, you know that exercise is good for you. Admittedly, some of the most thrilling - think mountaineering, cave diving or base jumping - are not entirely compatible with longevity, but maybe you can justify the risk by making a trade-off. If you smoke, quit now. Or cut down on some other major life-shortening habit such as binge-drinking, reckless driving or cheeseburgers. Alternatively, if you want a thrill but cannot justify the risk, go for safer kicks such as fairground rides, amateur dramatics, a new lover or bungee jumping.

Unfortunately, there is no evidence to suggest that getting your pulse racing extends longevity, but regular thrills will help to make your life feel longer. One of the more tiresome aspects of ageing is that while the days seem to drag, the years rush by. This paradox is not simply subjective: researchers are finding that our brains actually oscillate with a tick-tock that marks the passage of time, and this winds down as we grow older, making time seem to fly (*New Scientist,* 4 February, p34). As yet, scientists have not come up with a way to speed the clock back up, but building temporal landmarks with memorable experiences can create the opposite illusion, so the years seem to pass more slowly.

Longevity is surely not an end in itself. So, live a little! As T.S. Elliot said: "Only those who risk going too far can possibly find out how far they can go."