A few years ago, I came across an interesting Internet site that presented a list of the ‘elixirs of life’. I was immediately struck by these terms; good friends would say to me, ‘you should seek the elixirs of life’, and I would think, ‘what should I do if I want to remain healthy? Take these elixirs?’

In the 13th century, a time when food was very rich and the average life expectancy was less than 60 years, an elixir was a potion prescribed by the doctor that was supposed to promote health and longevity. The elixir was a vehicle through which the doctor administered a prescription. It was a mixture of herbs, spices, poisons, and other substances. The doctor’s knowledge of these substances was often based on superstition and hearsay, and the elixirs were often dangerous. The patient was often encouraged to drink the elixir, and it is possible that some of these elixirs did have beneficial effects, but it is also possible that they were harmful.

In the 19th century, the concept of the elixir was revived in various forms. People believed that certain substances, such as vitamins and minerals, could be used to prevent and cure illnesses. The elixir was often a mixture of these substances, and it was hoped that the elixir would have a beneficial effect.

In the 20th century, the elixir was replaced by scientific research. Scientists began to study the effects of various substances on the body, and they began to develop drugs that could be used to treat illnesses. The elixir was replaced by the pill, which was a more reliable and effective means of delivering the necessary substances.

The elixir may have disappeared, but the search for the elixirs of life continues. People are still looking for substances that can improve their health and longevity. The elixirs of life may be found in the foods we eat, in the exercises we do, or in the environments we live in. The elixirs of life may be found in the hugs we give, in the smiles we share, or in the love we receive.

The search for the elixirs of life is a never-ending one. It is a journey that we all undertake, and it is a journey that we all enjoy. The elixirs of life are not just substances that we consume, but they are also the experiences that we create. The elixirs of life are the things that make life worth living.

Telomeres obsession

The long list (the original one consists of 12 points) ends with the following fact: "We are talking in the wake of a study that was conducted in Kupiec’s lab by Dr. Gal Hugel Romano and Tami Huray. The study, which recently appeared in a prestigious scientific journal called PLOS Genetics, shows that caffeine and alcohol affect cellular aging and possibly also the development of cancer. It is correct to conclude from this that we should drink coffee in the morning and beer at the evening to stay young and healthy..."

But is it not like that at all, says Prof. Martin Kupiec, of the Department of Molecular Microbiology and Biotechnology at Tel Aviv University, who is also president of the Genetic Society of Israel. "As human beings, we are constantly on the look-out for statistical data and correlations or correlations of chance events. For example, when parasitologists are asked about the possibility of giving birth to a child with a certain disease – what do they understand from this? Or when you hand someone the calendar of last year, 2012, and there’s a comment there like ‘Your chances of contracting a certain disease are three times higher than those of the general population.’ It will usually frighten the person. But if the general population’s chances of contracting the disease are exactly the same as the chances of getting rich are those in a million, and that’s already a lot scarier."

"We have difficulty understanding probabilities in depth; especially when we are dealing with big numbers, and tend to confuse correlation with cause-and-effect relationship."

"For example, a headline that appears in the media: ‘Adopt a dog and to enjoy a better marital relationship!’ The article itself doesn’t say that couples that have a dog are happier than other couples. In other words, a correlation was found between owning a dog and marital bliss. The headline expresses a connection, according to which the dog is the cause of the happiness, and therefore the couple with a dog is able to live happily ever after. It is possible, of course, that dogs do affect the stress the dog brings into the marriage, and that those who raise a dog are, in general, more gentle and loving. People who work with dogs also report that they have less stress and that those qualities lead them to adopt a dog and not to be more capable and loving in their relationships.

A casual connection is always possible between two factors that are correlated, but it is also always possible that a third factor is responsible for both.

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other things it brings about. And you can also look for a third, completely different factor, that independently influences aging. Because aging is such a hot topic, people are terribly eager to find correlations and to conclude causality from them. It’s very easy to find correlations even in stressful examples of tissues that have indeed been found.

In 2004, Nobel Prize laureate Prof. Elizabeth Blackburn published a study that found that people who live with emotional stress have shorter telomeres than people who do not live with such stress. For the stressed subjects in the research, they took single mothers who have a child with a chronic disease; the non-stressed ones were single mothers with an ordinary child. I’m not sure that control population represented especially related to that, but...

The paper made a lot of noise because it linked a mental state to a molecular measure. The same authors published that meditation, too, causes telomeres to lengthen since longer telomeres had been found in people who led meditation than in other people.

Over time, connections were found between telomere length and other factors, such as the tendency toward heart attacks and cancer, trauma such as irrevocable divorce, and even social elements like the number of years of schooling. What is the significance of all of this? That is entirely unclear. When is the second one a result of another? When is the second one a result of the first? And when do both stem from a completely different factor altogether?

So what do we do? How can all this be decided?

“Matters is unresolved and cannot be resolved in humans because to determine a cause-and-effect relationship, you need a system in which it is possible to intervene, to alter one factor and to ascertain whether it affects the second factor.”

And you have a system like that.

“We work with yeasts, where the genetics are fully known to us. Their telomeres are well defined and we can manipulate their environment as we like and check it effect on cellular aging. This is a system from which it is truly possible to draw conclusions of causality and not just of correlation.”

It’s true that correlations are a shaky basis on which to draw conclusions, but what about drawing conclusions about humans from single-celled organisms that we make rolls with?

“No offense, but we are far less different from those organisms than perhaps we would like to think. Indeed, yeast has 6000 genes and we have only slightly more than three times that – close to 20,000 – but the similarity in the genes is astounding. Approximately 50 percent of the yeast’s genes exist in us as well, and our basic cellular mechanisms are so similar that you can correct a mutant yeast, which has a defective gene, by inserting the human gene into it.”

In other words, you are going with a very simple model system on the assumption that the basic and essential processes are similar in all organisms. Several important structures and processes in all living organisms, and therefore you can use this system to study tissues that are easy to work with in order to understand more complex organisms. Simple model systems have led to the most significant breakthroughs in the study of complex processes in biology: memory mechanisms are covered in the flybrain, embryonic development processes in transplacent worms and flies, and more.

“Today, yeasts constitute model systems for a great many human diseases whose molecular basis we want to understand. Many genes that are responsible for heredity diseases that exist in yeasts, as well, and so they can be studied in this simple system, which is also an ideal system for seeking cures for those diseases. Yeasts are even used to study diseases that are caused by protein buildup, such as muscular dystrophy, Alzheimer’s and Parkinson’s. There are a few differences, of course, between yeasts and us, but a certain aspect of those differences is precisely what enables us to work with them. For example, (there’s the fact) that they divide faster than our cells, that you can deliberately damage or modify their genes and you can expose them to all kinds of substances to test the effect. You can also put them in the freezer, which you can’t do with humans. But all that makes yeasts a very convenient system for work.”

**Precision is critical**

What has this model system enabled you to discover?

“We created, for example, all the mutants of the yeast. Yeast has 6,000 genes and we’ve got in the freezer 6,000 different strains, each of which is defective in a different gene. It’s as if I had in the freezer 20,000 varieties of humans, in each of which there was one inactive gene out of the entire human genome. Such a system can allow us to ascertain the role of each gene separately, and to understand what is the trait for which that gene is responsible.”

“Let’s test the role of telomeres in aging. First you have to find all the genes that affect their length. To do that, we scanned all the mutant strains and focused on those that have especially long or short telomeres. That is how we discovered a highly complex system, which controls telomere length and includes more than 400 genes. One preserved important number and it indicates the significance of telomere length in safeguarding the stability of the genome.”

“It turns out that telomere length is something that’s very exact, which suggests that precision is critical. The three times difference between gene expression is amazing, and it takes it for one of the genes to be harmed for the entire mechanism to be disrupted. When my students want to get something to eat at the university, a two-hour discussion ensues about which cafeteria they should go to. Eventually there is one person who decides and everyone follows her lead. Here there is a system of 400 ‘particulates,’ who take on each other and stick together, and in the end always make the same decision.”

This is the first time anyone has analyzed a complex system in which all of the genes affecting it are known. In this system, you can play with the genes and engineer them so as to ask questions regarding the interplay between heredity and environment. You can intervene in the environment – for example, by adding substances such as caffeine, and test how it affects telomere length. At long last, we no longer have to settle for correlations: We can actively alter the environment, and ascertain whether we are dealing with a mere correlation or a relationship of cause and effect.”

For example?

“For example, it is a unique opportunity to verify in a controlled manner whether stress really does affect cellular aging as claimed in Blackburn’s 2004 study.”

**Have you found single-parent yeasts with a sick child?**

“Ultimately, psychological pressure, like that tested among single mothers who have a chronically ill child, translates into chemistry in the body, into molecules such as free radicals. The hypothesis in Blackburn’s study was that in view of the emotional pressure single mothers are under, physiological changes take place in their cells as a buildup of free radicals. These molecules damage the cell and are what causes the shortening of telomeres. In keeping with this hypothesis, we grew our cells in conditions that generate free radicals and tested their effect on telomere length. To our surprise, the length did not change at all. In the wake of this, we decided to grow the cells under a wide range of additional conditions, and we saw that most did not cause a change in telomere length. This stems from the fact that the complex system is able to respond to the environmental cues and preserve the very particular length required.”

And the alcohol and caffeine?

“It turned out substances, to which we are exposed in our day-to-day life, had great effect on telomere length, and the most significant were caffeine and alcohol: A low concentration of caffeine (like in a cup of coffee) caused a significant shortening of telomere length, and a low concentration of alcohol (as found in beer) caused them to lengthen significantly.”

So is that a recommendation to drink coffee or beer?

“No. You cannot ask me to be a connoisseur of substances that offer to measure the length of your telomeres and, based on that, tell you your life expectancy and the length of your health span. There are at least two companies in the world today that do that, and unfortunately there are scientists who cooperate with them.”

Nevertheless, what can be concluded from your model system?

“We have discovered that despite the fact that telomere length is meticulously controlled, a few specific environmental factors can affect it. Whether the second factor is environmental conditions affect cellular aging, diseases related to aging, and cancer. As I said, because many genetic mechanisms that have been preserved in evolution, there is a chance that if we succeed in affecting the second factor, we can control and prevent aging in yeasts, in the future we will be able to offer prevention and treatment of human diseases by means of medications that act on the length of telomeres.”

Some final words on science and its application.

“You could say that science is a great gift to humanity because it finds cures for diseases and invents ‘gadgets’ that improve the quality of our lives. But, in my opinion, these are merely side effects of the scientific process. The purpose of science is to broaden our knowledge and understanding of the world. Most of the important scientific discoveries, of the kind that altered our understanding of life, have not been aimed at finding a cure for disease or inventing an appliance that will allow us to scratch our backs more efficiently. Telomeres, for example, and the enzyme that lengths them, were discovered by Elizabeth Blackburn while attempting to understand how certain genes in fruit flies change their DNA in fly cells. DNA replication is an open-ended process, and the enzyme called telomerase is what counts.”

“Absolutely. Because the road is brimming with amazing discoveries and insights, and some of them will surely also help us to live better.”

Prof. Elizabeth Blackburn, Provocative study.