Why micro-proteins enhance cancer growth

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Formulation of the problem. It has been recently discovered that, in addition to usual proteins, human cells contain a significant number of much smaller-size micro-proteins. It is important to analyze them because they enhance the growth of cancer cells – specifically, if we de-activate these micro-proteins, the growth of cancer cells slows down.

A natural question is: why simple micro-proteins enhance the cancer growth while more complex normal-size proteins usually do not?

The main idea behind our explanation. In general, the dynamics of many system is described by differential equations $\frac{dx}{dt} = f(x)$ for some function $f(x)$. When the function $f(x)$ is unknown, physicists usually take into account that a function $f(x)$ can be expanded in Taylor series $f(x) = a_0 + a_1 \cdot x + a_2 \cdot x^2 + \ldots$ Terms in the Taylor series usually decrease, the contribution of the terms proportional to x^n decreases with n. So we can get a good approximation to the actual behavior of the system if we keep the first few terms in the Taylor expansion, and take $f(x) = a_0 + a_1 \cdot x + \ldots + a_k \cdot x^k$.

Usually, the simpler the system, the fewer terms are needed to describe its behavior. To describe the behavior of the simplest systems, it is usually sufficient to consider only linear terms. To adequately describe more complex systems, we need to use quadratic – and sometimes even higher order – terms.

Resulting explanation. Let us apply the above idea to our problem. Micro-proteins are much simpler than the usual ones, so it makes sense to assume that their dynamics is adequately described by linear terms in the Taylor expansion, i.e., by the equation $\dot{x} = a_0 + a_1 \cdot x$. In the general case, $a_1 \neq 0$. In this case, for $X \stackrel{\text{def}}{=} x + a_0/a_1$, we have a simplified equation $\dot{X} = a_1 \cdot X$. It is well known that each solution to this equation has the form $X(t) = C \cdot \exp(a_1 \cdot t)$. When $a_1 < 0$, we get a decrease, the only growth case is when $a_1 > 0$. In this growth case, we have an unlimited exponential growth – which is exactly what cancer is about.

To describe the dynamics of normal-size – more complex – proteins, we need to take into account at least quadratic terms: $\dot{x} = a_0 + a_1 \cdot x + a_2 \cdot x^2$. Here too, growth corresponds to $a_1 > 0$. When $a_2 > 0$, we also have unlimited growth, but when $a_2 < 0$, the growth stops when we reach the value x_0 for which $a_0 + a_1 \cdot x_0 + a_2 \cdot x_0^2 = 0$. In general, it is reasonable to assume that positive and negative a_2 values are equally probable. Thus, in the growth cases, the probability of $a_2 > 0$ is about $1/2$. So, normal-size proteins enhance unbounded cancer-type growth only in half of the growth cases, while micro-proteins enhance such growth in twice more cases.

This explains the observed fact: that micro-proteins are more probable to enhance cancer growth.