

Questions and Answers about Curing Cancer

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Can metastatic cancer be cured today?

Yes. Some types of metastatic cancer can be cured today with combination chemotherapy. The cure rate for childhood cancers is 80%. The cure rate for testicular cancer is 96%. However, the [five-year survival rate for all types of cancer](#) is only about 60%.

Why is metastatic cancer not consistently cured?

Current cancer therapies fail to satisfy three critical requirements: **comprehensiveness, specificity and knowability**. Comprehensiveness is the ability to kill all malignant cells that are present and that could evolve in a patient. Specificity is the ability of therapy to kill cancer cells and spare normal cells. Therapy must target properties of cancer that are "known" or in principle "knowable."

Why does cancer chemotherapy produce side effects and patient toxicity?

Most current cancer drugs lack tumor specificity and are almost equally toxic for cancer cells and normal cells and the patient.

How do most current cancer drugs work?

Most cancer drugs inhibit cell proliferation. Proliferation or cell replication is an absolute requirement for cancer. However, it is also an absolute requirement for life and health.

What does the term specific cure mean?

The specific cure of cancer is the cure of cancer without significant patient side effects and toxicity. This means that the therapy can kill all malignant cells that evolve in the patient without causing significant harm to normal cells and tissues.

Are research groups currently working to develop a specific cure for cancer?

No.

Has any established cancer organization formulated a plan to develop a specific cure for cancer?

No.

Why is work not being done to develop a specific cure for cancer?

- The specific cure of cancer is widely regarded as impossible or highly infeasible.
- Cancer is widely regarded as hundreds of different diseases.
- It is commonly believed that each type of cancer will require different therapy.
- The goal of most cancer research has shifted to the chronic control of cancer.

Why has the focus of much cancer research shifted to chronic control?

- Despite decades of research it has not been possible to extend the successes of combination chemotherapy to the cure of cancer in general.
- It seemed to many that the cancer therapies were often worse than the disease and impaired quality of life.
- Advances in molecular biology exposed the enormous complexity of cancer, but failed to reveal any pathways to the cure of cancer.

- Frustration grew both within the cancer community and among patients.
- A consensus formed that the cure of cancer is in the words of the director of the NCI, "really just a dream."

Can cancer now be chronically controlled on a consistent basis?

Many patients can now have their cancer controlled for a long period of time. However, it is not now possible to consistently control cancer. The requirements for the consistent control of cancer are virtually identical to those for the cure of cancer, comprehensiveness and specificity. At a very fundamental level the requirements for the cure and chronic control of cancer are the same.

Why after \$200 billion and decades of research has cancer not been cured or controlled?

Tumor cell evolution is the problem. Cancer cells mutate and evolve in a random, unpredictable manner. An almost unlimited variety of cancer cells can arise in a patient, and the cancer cells keep changing. The bottom line is that cancer is an astronomically complex disease.

Can we understand cancer?

No. We can perhaps understand individual cancer cells. However, a patient with cancer can have billions of genetically different cancer cells spread throughout his or her body. There is no logically valid way to generalize from observed cancer cells to all cancer cells in the patient. This imposes a fundamental limit on what can be known about cancer.

Do we need to understand cancer to cure it?

No. Childhood leukemia, lymphoma, and testicular cancer were all cured with no understanding of the molecular lesions that cause the disease.

Can we know what will evolve in a patient with cancer?

No. Cancer is an enormously diverse, stochastic (random), unpredictable evolutionary process. It is impossible to accurately know or predict what will evolve.

Is there any way around this limitation of knowledge?

No. This is true as a matter of pure deductive logic. If we are to cure cancer we must accept and deal with the limitations of knowledge imposed by tumor cell evolution. This matters because a single malignant cell can after only forty cell doublings give rise to a lethal population of one trillion cancer cells.

Do we need to know what has evolved or what will evolve to specifically cure cancer?

No. It is sufficient to know what could evolve. We can specifically target [the set of all malignant cells that could evolve](#). This set is "knowable" by means of a "true" scientific theory that [resists falsification](#).

Are there any known molecular targets that are characteristic of all cancer cells?

No. Tumor cell evolution strongly suggests that none exist. Virtually any molecular target that is directly or indirectly encoded by DNA can be lost or modified by mutations during tumor cell evolution.

There has been a lot of publicity about targeted cancer drugs directed against tumor specific genetic lesions. Do these drugs work?

The drugs have largely been disappointing. Sometimes a beneficial effect is seen. However, in time cancer cells generally evolve that are drug resistant and the cancer progresses. The duration of the anticancer response is often measured in just weeks. Very good results have been seen in the treatment of chronic myelogenous leukemia, (CML). The rate of relapse is about 4% per year in patients treated with the targeted drug, Gleevec. However, CML is not typical. CML, unlike most cancers evolves, at a very slow rate.

What is the problem with drugs targeted to the genetic lesions of cancer?

The drugs lack comprehensiveness. There are so many possible routes of tumor cell evolution that it is highly improbable and impractical, (if not impossible) to achieve comprehensiveness by targeting the genetic lesions of cancer. This has led to the notion of individualized cancer therapy.

What is the idea behind individually tailored cancer therapy?

The idea is to identify the genetic lesions that are present in a particular patient's cancer cells and then to treat the patient with drugs that are specific for those lesions.

Can cancer be consistently cured by individually tailored therapy?

No. The concept is inconsistent with the enormously diverse, unpredictable evolutionary nature of cancer. It presupposes knowledge that is unknowable. We generally do not know all the different types of cancer cells that have evolved in a patient with metastatic cancer and we cannot know what will evolve. Tumor cell evolution is unpredictable. To cure cancer every malignant cell must be killed. In addition, there are so many different genetic alterations that a huge number of different drugs would need to provide comprehensive targeting. The fundamental problem is that we cannot know what will evolve.

Can the immune system consistently cure cancer?

No. A small number of patients have been cured of cancer by various types of immunotherapy. The problem is tumor cell evolution. [Cancer cells can and do evolve that can escape destruction by the immune system.](#) The immune system can be specific but lacks comprehensiveness for all malignant cells that could evolve in the patient.

Can drugs that inhibit tumor blood vessel formation consistently cure cancer?

No. New blood vessel formation or angiogenesis is only one mechanism by which tumor cells can be supplied with oxygen and a blood supply. Tumor cells can also grow along pre-existing blood vessels. This process is called [vascular co-option](#). In addition, some tumors can acquire a blood supply by a process called vasculogenic mimicry in which the tumor cells form blood vessel like structures. In order to starve tumors all three processes must be shut off.

Can cancer be consistently cured by targeting properties of individual cancer cells?

No. This would require comprehensive knowledge of what has evolved, which is not [generally possible](#).

What is the required target for the cure of cancer?

Since we generally do not know all that has evolved and cannot know what will evolve in a patient, the required target for the consistent cure of cancer is [the set of all malignant cells that could evolve](#). Therapy that targets a lesser set will fail.

What is a malignant cell?

A malignant cell is a cancer cell that engages in proliferation and invasiveness in an abnormal context. Only malignant cells can sustain the disease of cancer. Killing all malignant cells will cure cancer.

Are all tumor cells that evolve malignant?

No. Many tumor cells are dead end and cannot proliferate and invade.

Can the set of all malignant cells that could evolve in a patient be directly observed?

No. [The set is an abstraction](#). Most of the cells in the set have never existed and never will exist.

How many different types of malignant cells could potentially evolve in a patient?

An [almost unlimited number](#) of genetically different malignant cells could potentially evolve.

What can be known about the set of all malignant cells that could evolve in a patient?

- Very little can be known. However, enough can be known to specifically cure cancer.
- We do know that all malignant cells must at engage in malignant behavior, which is defined as proliferation and invasiveness in an abnormal context. This is true by definition.

- We do know from Darwin's Theory of Evolution that all malignant cells that could evolve will use normal cellular machinery to carry out proliferation and invasiveness.

Proliferation and invasiveness are highly complex processes. There is not sufficient time during the life span of a patient for extensive new functional cellular machinery to evolve. Therefore, all malignant cells that could evolve must use normal cellular machinery to proliferate and invade. An exception to this rule has never been observed. On statistical grounds we can be confident that an exception will not be observed.

Why is it important to understand what can and cannot be known about cancer?

Only properties of cancer that are known or in principle knowable can be targeted. This applies to all mechanisms of targeting. The immune system is not an exception.

Is the normal cellular machinery that carries out proliferation and invasiveness known?

Yes. The biochemistry of these processes has been extensively studied and is already reasonably well known.

How can malignant behavior be detected?

The only way to detect malignant behavior is on the basis of abnormal patterns of normal cellular machinery that effect or reflect the component functions of proliferation and invasiveness. This is also the only basis for the detection of malignant cells. Unless a cell engages in malignant behavior we cannot know if the cells is malignant.

If the genetic diversity of cancer is nearly unlimited then isn't the diversity of the cellular machinery that carries out malignant behavior also nearly unlimited?

No. [The normal cellular machinery](#) that potentially can carry out the processes required for malignant behavior are fixed, finite and encoded in the normal human genome. It is totally independent of the genetic chaos of cancer.

While any given piece of normal cellular machinery can be altered by genetic alterations during tumor cell evolution, the joint probably of mutations to multiple (#n) pieces of cellular machinery related to proliferation and invasiveness rapidly approaches zero (as the #n increases).

Large-scale gene sequencing in breast and colon cancer cells has revealed a [staggering degree of genetic complexity](#) with a unique set of genetic alterations in every patient. However, it has also shown that the vast majority of genes in cancer cells are not mutated.

Do malignant cells express malignant behavior continuously?

No. Malignant behavior is expressed intermittently. However, at some point in time a malignant cell must engage in malignant behavior.

Do normal cells engage in proliferation and invasiveness?

Yes. However, the combination is absent from most normal tissues. It is present in certain normal processes such as wound healing, angiogenesis (new blood vessel formation), placental implantation and fetal development.

If these processes are excluded then the patterns of normal cellular machinery related to proliferation and invasiveness provides an excellent basis for the detection of malignant cells.

Can the set of all malignant cells that could evolve be detected on the basis of a single pattern of normal cellular machinery?

No. Any pattern can be lost or not expressed during tumor cell evolution. Multiple patterns are required for comprehensiveness.

What is the General Theory of Cancer?

There exists a set of patterns of normal cellular machinery such that:

- Each pattern effects or reflects the combination of proliferation and invasiveness; [1]
- Each pattern is absent from normal tissues not engaged in these processes;
- All malignant cells express at least one of the patterns[2].

Is the General Theory of Cancer true?

The theory makes a universal statement about all malignant cells. [3] Like all scientific theories it cannot be proven true. The demonstration of billions of malignant cells for which the theory holds true provides no validation. However, a single malignant cell that failed to express at least one of the patterns would falsify the theory.

For the theory to be wrong would require:

- I. The non-existence of a set of patterns of normal cellular machinery that enable the specific detection of proliferation and invasiveness; or
- II. The evolution of a malignant cell that failed to use normal cellular machinery that comprised any patterns in the set

Case I would mean that specific molecular signatures of proliferation and invasive do not exist. This is not tenable as the processes exist and occur within the domain of cellular machinery.

Case II would mean the evolution of extensive new functional machinery and constitute a miracle.

The theory by its very construction is designed to be almost certainly true. However, it is far too general for practical use in its present form. What we need is a more specific version of the theory.

Let us now consider the smallest number “n” of patterns for which the general theory resists falsification. This set of “n” patterns is the minimal set of target patterns needed for the consistent and specific cure of cancer or control of cancer.

This minimum set will also be the set of simplest patterns with the fewest elements per pattern. (Pattern AB can detect more cells than pattern ABC. Pattern AB detects all cells with both A and B. Pattern ABC detects only cells with all three together, A and B and C.)

What is a target pattern?

A **target pattern** is a set of at least two proteins or biomolecules that are expressed by malignant cells and which are characteristic of proliferation and invasiveness.

What is a comprehensive set of target patterns?

It is a set of patterns such that any malignant cell that could evolve will, at some point in time, express at least one pattern of the set. The patterns can be expressed by the malignant cell and or its microenvironment.

Does a comprehensive set of target patterns exist?

The General Theory of Cancer tells us that a comprehensive set of target patterns must exist.

Can this comprehensive set of “n” patterns be identified?

Yes. The elements of the patterns are components of normal cellular machinery that effect or reflect proliferation and invasiveness. A finite number of normal proteins (and other biomolecules) are involved. Using routine techniques the expression of simple patterns of these proteins can be examined in a wide range of normal tissues, tissues engaged in proliferation and invasiveness (i.e., wound healing) and malignant tissues. A set of “n” patterns can be identified that can detect all examined instances of proliferation and invasiveness.

A major technical objective of the Cure Cancer Project is to identify a comprehensive set of target patterns.

How many patterns will be required for the comprehensive detection of all malignant cells that could evolve?

The number “n” is currently unknown. We estimate that approximately 5 to 10 different patterns will be required. The exact number needs to be determined experimentally.

Can comprehensiveness be proven?

No. However, an exception would prove the set is not comprehensive and the highlight the need for additional patterns.

How many proteins or different biomolecules will comprise a pattern?

Two or three should suffice.

Why are the patterns important?

The patterns provide the only basis for the comprehensive detection and destruction of all malignant cells that could evolve in a patient. The evolutionary nature of cancer implies that any process that can consistently and specifically cure cancer or control cancer must target these patterns.

What does it mean for a drug to target a pattern of proteins?

The drug will kill cells if and only if they express the entire pattern of proteins. The drug will not kill cells that express only some of the proteins that comprise the pattern. In other word, specificity is for the pattern not the individual proteins that comprise the pattern. This is called Pattern Recognition Tumor Targeting, (PRTT).

Why is PRTT important?

Some type of **PRTT is required** for the consistent and specific cure or control of cancer.

Can cancer be consistently and specifically cured or controlled cancer without targeting patterns of normal cellular machinery?

No. This follows as a matter of deductive logic from the evolutionary nature of cancer.

Are any organizations currently working to identify a comprehensive set of patterns for the detection of all malignant cells?

No.

Are any organizations currently working to develop PRTT?

No. The development of PRTT is a major goal of the Cure Cancer Project.

What does the Cure Cancer Project plan to do?

- Identify and select a comprehensive set of target patterns
- Develop PRTT drug technologies
- Develop a set of PRTT-based drugs for the specific cure or control of metastatic cancer

Are there any guarantees of success?

No. The Cure Cancer Project plans to do what has never been done before --- develop a specific cure for cancer. Just as there were no guarantees that man could walk on the moon or that polio could be prevented, there can be no guarantees of success.

However, if cancer is to be cured it will take a focused, goal-oriented, engineering project aimed at addressing the requirement for cure. The evolutionary nature of cancer implies that the consistent and specific cure or control of cancer will require targeting patterns of

normal cellular machinery that carry out proliferation and invasiveness. We believe that the specific cure of cancer is a solvable engineering problem that is well within the scope of existing science and technology.