If you were diagnosed with cancer 35 years ago, you had a 50 percent chance of surviving for five years. Today, if you are one of the 1.6 million people diagnosed with cancer in 2011, that rate is 68 percent. While that means that the five-year survival rate has increased by an impressive 36 percent since the mid-1970s, much of that progress is due not to improvements in cancer treatment, or better understanding of the disease processes, but rather to improved detection technologies and screening rates.

In that time period we have learned that there are many types of cancer, some say almost as many as there are cases. The reality is that while we have made enormous strides in our understanding of the many diseases we collectively call cancer, much of that improved understanding has served to underscore just how much we do not know. While more targeted and personalized treatments have begun to reach the clinic, we are still in an era in which almost 12 million Americans are struggling with cancer, the disease is claiming more than a half million lives annually, and improvements in treatment are measured not in terms of cures, or years of additional survival, but rather in terms of additional months of struggling with a terrible disease.
The cancer stem cell hypothesis

Winning this seemingly endless “War on Cancer” requires that we make major strides in understanding what causes otherwise normal cells to run amok, and what allows them to break all the normal rules of cell division and spread throughout the body. That is where stem cells come in. The discovery that cancers contain distinct subpopulations of cells led to the Stem Cell concept of cancer, which proposes that a small subpopulation of self-renewing tumor cells is responsible for tumor formation and disease spread. The cancer stem cell hypothesis departs from traditional models, which postulate that genetic alterations may transform any mature cell and that therefore all cancer cells are equally capable of initiating tumors.

Cancer stem cells are not only capable of self-renewal and of propagating the disease, but may also become virulent via immune system evasion and drug resistance, explaining two of the most challenging aspects of cancer: resistance and recurrence. Often, radiation or chemotherapy shrinks tumors, sometimes to the point where they are no longer detected, yet the disease returns.

Cell targeting

Therapeutic targeting of cancer stem cells and an understanding of their virulence mechanisms holds promise for the development of more effective therapies and the eventual eradication of this dreaded disease. The scientists who are part of the Harvard Stem Cell Institute’s Cancer Program are primarily focused on this particular and numerically minor population of cells that are believed to cause cancers to grow exponentially. The main goal of the program is to identify critical genes and pathways that sufficiently distinguish cancer from normal stem cells and hence serve as candidate targets for new therapeutic approaches. This knowledge is essential to develop novel treatments that can target malignant stem cells while sparing their normal counterparts. Based at Dana-Farber Cancer Institute, Children’s Hospital Boston and several of Harvard’s other affiliated teaching hospitals, a number of these researchers are not only laboratory scientists but practicing oncologists, connecting the lab and the clinic.

Cross-program cooperation

In addition to the work being done by investigators in HSCI’s Cancer Program specifically, scientists in several HSCI programs are also doing research that has either direct, or indirect, implications in improving cancer treatment. For example, one group of scientists in our Blood Program is making real strides in understanding the cellular mechanics of blood stem cell transplantation which will ultimately lead to improvements in the efficacy of this life-saving cancer treatment. And working with zebrafish, other scientists have progressed from developing a zebrafish model of melanoma, the deadliest form of skin cancer, to developing a treatment that is about to go into human trials.

Like all of HSCI’s research programs, our efforts to understand and combat cancer are both broad and deep, and like all the other programs, are collaborative efforts that span departmental, disciplinary, and institutional boundaries across HSCI.