In order to fully understand molecular biology, one must understand what a molecule is. Atoms are the ‘building blocks’ of life, but a molecule is a group of atoms that have bonded together. A molecule is the smallest unit of a chemical compound. In it’s essence, molecular biology is a branch of the broader topic that deals with structure and function of macromolecules essential to life. The subject is mostly concerned with comprehending interactions between systems inside of a cell including: DNA, RNA, and protein biosynthesis. This particular field also overlaps with other topics in this branch of study; chemistry, genetics, biochemistry. This also includes the study of genes and control of their expression in cellular and organismal function. However, there is no definite line between these disciplines. Researchers today have increasingly combined ideas and techniques from these topics with those of traditional molecular biology methods.

A copious amount of molecular work is quantitative. Lately, much work has consolidated molecular biology, computer science in bioinformatics, and computational biology. The study of gene structure and function has been the most prominent sub-field of this subject since early 2000. Many other topics in biology have been focusing on molecules: studying interactions in cell biology, techniques used in evolutionary biology (population genetics and phylogenetics), along with a tradition of studying biomolecules in biophysics.

The big question now is how we can apply this to further disease and medicinal discoveries. Particularly with an incredibly diverse disease with some known genetic affiliations such as cancer. Cancer, essentially, is when damaged cells in a body divide uncontrollably forming masses of tissue called tumors. The tumors will grow and interfere with the different systems of

the body; digestive, nervous, and circulatory. This releases hormones altering normal body function. When, said tumor, spreads around the body, destroying healthy tissue, the process is called metastasis (this is what differentiates a benign tumor versus a cancerous one). At this point it becomes difficult to treat. How cancer spreads, which has been earlier hypothesized, has something to do with cells' adhesion properties. Particular molecular interactions between cells and what holds them in place cause them to 'unstick' at original tumor site. Becoming dislodged and move to reattach at a new site. This is an incredibly important discovery since cancer mortality is mostly due to metastatic tumors. Only around ten percent of deaths by cancer are caused by initial tumors. Finding ways to stop diseased cells from sticking at new sites could prohibit metastatic disease, halting growth of new tumors. Metastasis is, however, incredibly rare. Cancerous cells will leave the initial tumor site and enter the bloodstream, but typically will not lodge itself into another part of the human tissue.

An important factor is our DNA. DNA stands for deoxyribonucleic acid and is made up of nucleotides thymine, cytosine, adenine, and guanine, with a sugar phosphate backbone. An important fact is that adenine and thymine are always together and cytosine and guanine are always a pair. This macromolecule is the main constituent of chromosomes and it is is carrier of genetic information. There are specific genes involving cell division in our bodies. If there are mutations that inhibit those genes than it will lead to uncontrollable cell growth. There are four types of genes responsible for cell division. Oncogenes tell the cell when to divide, tumor suppressor genes tell a cell when not to divide, suicide genes control apoptosis and tell a cell when to kill itself if, when, something goes wrong, and DNA repair genes tell a cell when to repair a damaged portion of DNA.

Diseases of many types, scientists have found, trace back to our DNA. Mutations that occur on different strands cause people to have a predisposition to said diseases including cancer. Places like the Memorial Sloan-Kettering Cancer Center are currently looking into how genetic predispositions affect families and the population. There are two types of mutations that can occur in the body: somatic (gene mutations that happen randomly in one or more cells), or hereditary mutations (typically inherited from one or both parents, and are present in nearly every cell in the body). In a specific example in DNA, the tumor suppressor gene, p53, was discovered to be linked to breast cancer. Another gene linked to breast cancer would be the BRCA1 gene. This gene is involved in transcriptional regulation in response to DNA damage. Linked to breast cancer and early onset (meaning it comes very early in your life). Advanced technologies have been produced to personalize and achieve great, new discoveries to what can be done to fully understand breast cancer and how to cure it. This also allows us a chance to have a genetic test done to see whether or not people are at higher risks for this type of cancer.

Many research groups all over the country have been addressing important questions relevant to cancer studies. These include growth control and differentiation, genomic instability, cell signaling, cancer metabolism, and metastasis. A lab, the San Diego Branch of the Ludwig Institute, has been working with small molecule discovery. Analyzing the effects of small molecules on signaling, cell division, motility and metabolism have provided a foundation for disease relevant cellular pharmacology. An important step that has allowed up to fully understand what proteins and DNA looks like is through crystallization. Taking images and 3d capturings of such molecules has enabled us to fully see what they look like and how they potentially interact with one another. Since the spread of cancer is through such molecular

interactions this proves to be an incredibly interesting study that can help lead to a possible drug that reacts with such interactions restoring the damaged signals that one's genes send through cells that creates proteins that nourish cancer growth.

NCI clinician-scientists have begun creating detailed, three dimensional images of the prostate. They have been doing this with a special machine called the UroNav. This is a stylized computer that fuses together images from magnetic resonance imaging and ultrasounds. This will help guide precision biopsies and also opening up new prostate cancer diagnostics and treatment. Many new machines since the original, and continuing, hunt to write the human genome have created new ways to look at cancer research at it's very heart. However, there is still another problem that arises in the search for being able to rid the body of cancer, particularly advanced types. This difficulty is that the tumors that grow are also very different from one another when it spreads. Having therapies that are specific for the tumors of each individual patient is difficult. Not only this, but drugs and therapies currently existing do not only affect infected cells, but also the healthy ones. Cancer cells may be weaker, but because drugs affect healthy ones too it can cause side effects. Such as loss of hair because the protein responsible for hair growth becomes prohibited through chemotherapy and radiation. Continuing the research that has started, and looking into the way molecules affect disease, can possibly help us overcome the incredibly diverse disease, cancer.

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