Biotechnology: A Flag of Many Colors

At the opening of the National Biotechnology Week held on the 24 November 2008, Philippines' Department of Science and Technology Secretary Estrella Alabastro described biotechnology in the following way:
"If we could weave a flag for biotechnology, it would have three colors. Red for medical, green for agricultural, and white for industrial applications."
Since biotechnology is a multi-disciplinary science, it moves through various fields, such as medicine, marine, environment, and industrial fields. During her speech, Alabastro also said that more colors would be added to the biotechnology spectrum, and these have indeed happened.

Let's take a look at the four main colors of biotechnology, before exploring the other colors that have been added.

What Are the 4 Types of Biotechnology?

The four main types of biotechnology are medical biotechnology (red), industrial biotechnology (white), environmental biotechnology (green), and marine biotechnology (blue).

Let's look at each one in greater detail to find out what they're focused on and what they do.

MEDICAL "RED" BIOTECHNOLOGY

Medical biotechnology is all about human health and medicine. So, medical biotechnology will involve producing new pharmaceutical drugs, antibodies, vaccines, and more.

Red biotechnology offers a lot of value to the pharmaceutical industry and the medical profession. It helps to enhance patients' quality of life while also alleviating the experience of pain and suffering.
Red biotechnology can figure out the best drug dosages for patients, thus working towards making drugs and treatments much more specific for people based on their genetic code. **This is going to change the future of medicine** and ensure that doctors will treat their patients in a more unique, personal way.
Red biotechnology makes use of biological materials to find solutions to health-related problems. Often, gene expression, antibodies, and proteins are researched to find how they can be used to create genetically-modified cells or organisms to assist in treating various diseases.

Some examples include how proteins have been modified to encourage the production of enzymes in hamster cells and these can be used to treat heart disease in humans.

Red biotechnology is considered to be an inclusive field of research that uses biological processes, treatments in conventional forms and advanced forms (such as genetic engineering), and diagnostic methods to detect disease, as Wise Geek reports.

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This approach has resulted in biotechnologists working on finding cures to various human diseases, such as AIDS and hepatitis.

INDUSTRIAL "WHITE" BIOTECHNOLOGY

Industrial biotechnology affects many sectors, such as the textile, food, and energy sectors.

It is, in fact, the largest branch of biotechnology! Its focus is on using technology to create new processes with the use of fewer natural resources and energy as compared to conventional methods.

So, industrial biotechnology makes use of living cells derived from sources such as plants, bacteria, and yeast, and creates products that need less resources (such as energy) during their production. **They also produce less waste**.
There have already been valuable developments made by industrial biotechnology. An example is how the use of bacterial enzymes have been used to manufacture food as well as to make washing powder so as to decrease artificial ingredients, as EMBO Reports explains.

ENVIRONMENTAL AND AGRICULTURAL "GREEN" BIOTECHNOLOGY

These two areas of biotechnology are both put into the "green" color category.

Basically, green biotechnology concentrates on technologies related to agriculture, such as when it comes to finding ways to produce stronger crops or creating new biopesticides to reduce how many chemicals are used by farmers.

Other projects that agricultural biotechnologists will be involved in include the following:

- Using bacteria to encourage plant growth and improve crop yields.
- Using plants to remove heavy metals from the environment that can be toxic to it as well as to human health.

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- Using genetic manipulation to help plants thrive in spite of damaging weather conditions, such as frost.
- Using technology in animal breeding, such as the use of artificial insemination, which is said to be the most widely applied animal biotechnology.

As for environmental biotechnology, the main goal is combining biology with engineering. This can develop various processes to clean contaminated sites.
Fungi, bacteria, and microbes are often used as organic ways of eliminating pollutants in the environment. Some tasks that environmental biotechnologists will have include the following:

- Converting plants into biofuels.
- Inventing plant-based bioplastics that are kinder to the environment and can reduce waste.
- Engineering microbes or plants that can process and eliminate toxins and contaminants in the environment.
- Using geographic information systems to find and map contaminated sites as well as how the pollutants spread.
- Transforming waste into biogas or other natural sources of energy.
- Finding ways to make industrial processes cleaner, such as by using biological enzymes instead of chemical substances.

MARINE "BLUE" BIOTECHNOLOGY

Blue biotechnology is sometimes regarded as the fourth main type of biotechnology. It refers to the study of marine organisms with a focus on using these organisms for various human purposes, such as creating new medicines or food supplements to enhance human health.

Blue biotechnology makes use of a wide variety of marine organisms and resources for various tasks, such as shellfish, algae, and other substances. For example, the use of ziconotide, a substance derived from the venom of cone snails, is said to be an effective human painkiller.

An exciting idea is using marine biotechnology to create alternative sources of energy. Biofuel, for example, can be made from microalgae. The benefit is that algal biomass can be artificially grown without competing with other plants.
The industrial sector benefits greatly from "blue" biotechnology. Various proteins, biopolymers, biomaterials, and enzymes are produced in large quantities from the marine ecosystem.

Examples include biotechnology products such as green fluorescent protein derived from jellyfish that's used to create energy due to how it reacts to UV light.

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The Other Biotechnology Colors

While we might concentrate on the above four types of biotechnology, new fields of research have been established and they have their own colors. Here's what to know about them.

YELLOW BIOTECHNOLOGY


Jewel bug (Mating pair)

This one is very similar to green biotechnology that we talked about earlier, but it refers to biotechnology that makes use of insects. It uses active genes or traits in insects for research or other medical or agricultural processes.

Insects' gene functions are studied and then if they're considered useful they can help to make various processes better and more sustainable. Insects have much molecular diversity so they are valuable when it comes for use in biological processes.

That said, **some insects are also pests that can compete with us for human food**, such as by damaging our crops. Therefore, yellow biotechnology also involves the use of technology to control pests in a more sustainable and natural way.
To make things a bit complicated, yellow biotechnology has also sometimes been used to refer to using biotechnology to produce food, such as by making cheese and wine via fermentation.
According to this definition, it is also concerned with sustainability, and a large part of this issue concerns the meat industry as it uses a large amount of environmental resources.
Yellow biotechnology, in this way, is therefore focused on improving food production practices, such as by eliminating the use of antibiotics and hormones during meat production.

The use of genetically engineered crops to encourage healthier, more productive harvests, also forms part of yellow biotechnology when it relates to food production.

GREY BIOTECHNOLOGY

This is quite similar to green biotechnology. It focuses on the use of living organisms to improve our environment.

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So, it can include removing pollutants from the environment with the use of microorganisms. Other tasks and processes that can fall under grey biotechnology include the following:

- Protecting the flora and fauna from pollution.
- Human waste disposal and management with the use of microorganisms.
- Controlling pollution with the use of microorganisms.

An exciting example of grey biotechnology involves finding ways to reduce and eliminate our use of plastic. As you know, plastic causes much waste and contains chemicals that pollute the environment while also being potentially dangerous for our health.

In 2016, Japanese researchers found bacteria in a bottle-recycling plant called Ideonella sakaiensis that digests plastic used to make single-use plastic bottles, as Prescouter reports.
There has since been other research conducted on this problem of plastic pollution, and it's exciting to think that the plastic problem we deal with can be eliminated by making use of naturally-occurring microorganisms!

BROWN BIOTECHNOLOGY

Brown biotechnology is similar to grey biotechnology. Sometimes it's referred to as "Desert biotechnology." Its main focus is on treating desert-like soils to make them more productive.

To achieve this, it draws from species that are resistant to these dry soils and uses them in positive ways. It involves GM technology to create better-quality seeds that can grow crops in arid areas where there are low amounts of rainfall.

There are already crops that are resistant to desert conditions because of how they have been genetically engineered.

An example is DroughtGard. It was approved by the U.S. Department of Agriculture and makes use of protein derived from bacterium known as bacillus subtilis that ensures the corn plant will be able to thrive during water shortages.

This is an important branch of biotechnology because **70 percent of the earth's dryland is negatively affected by desertification** and one billion of the world's population is impacted by it, as the Electronic Journal of Biotechnology reports.

Some research, such as that published in Business Korea, has pointed out the fact that much desertification is as a result of poor management of soil and destruction of forests, but that cultivating crops in these areas can solve the problem.
Therefore, the development of genetically modified crops such as sweet potatoes and alfalfa are being researched to alleviate the problem of desertification while also providing food for the hungry.

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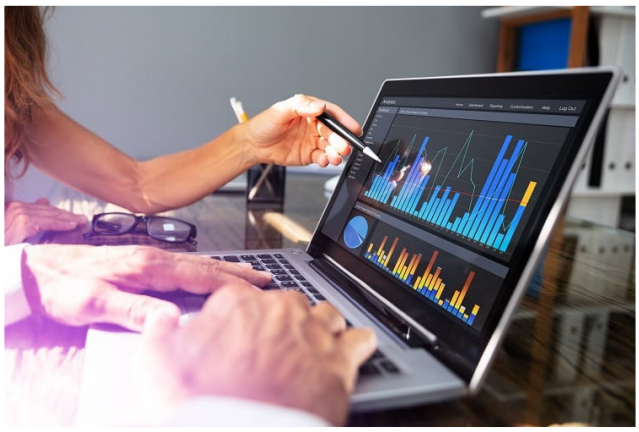
GOLD BIOTECHNOLOGY



Gold biotechnology is quite different from other types of biotechnology we've already explored because it's sort of the type of biotech that occurs behind the scenes.

Gold biotechnology concentrates on informatics, such as hardware and software, that's used in the data analysis of biological processes. It's sometimes referred to as "bioinformatics."

It makes use of computational techniques to allow for quick organization and analysis of biological data. But it also can search for changes in DNA and primers.
Big commercial companies, such as pharmaceutical companies, use bioinformaticians to maintain their complicated bioinformatic requirements. Input from these experts is very valuable – as precious as gold!
Just think about it: if you can't manage and store all the important information that you've researched, **how could you ever move forward and build on it**?
Gold biotechnology has allowed for computer networks that provide easy access to biological data and has developed software that researchers can use to analyse their findings without a hassle.

VIOLET BIOTECHNOLOGY

Violet biotechnology is quite unique in that it concentrates on the study of legal aspects that affect biotechnology. It also deals with ethical and philosophical issues. Violet biotechnology will study the moral impact of some technologies, such as gene therapy, and biosecurity.

Violet biotechnology was created in 1980 when the U.S. Supreme Court decided that genetically modified microorganisms could be patented, as Chemik reports.
In order to better understand violet biotechnology, **we can say that it helps to better maintain all the inventions** that other types of biotechnology achieve and study.
Some tasks involved in violet biotechnology include safeguarding intellectual property rights, analysing and publishing research, and safeguarding patent rights regarding inventions.

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There are some obstacles faced by violet biotechnology, such as when it comes to how certain types of biotechnology should be regulated and treated. An example is the use of GMOs and gene therapy, which raise many ethical issues and concerns.

DARK BIOTECHNOLOGY

This is known as the black sheep of the biotechnology family. Every scientific tool has a dark side, in which it can be used by people for malicious purposes. Dark biotechnology is an example of this. It refers to crimes such as bioterrorism and biowarfare.

It focuses on investigating pathogenic and resistant microorganisms so that they can be transformed into biological weapons. We can say that dark biotechnology is good science that has ended up in the wrong hands and is being used to harm instead of heal.

We can learn more about dark biotechnology by considering an experiment that was conducted in 2002. Dr. Eckward Wimmer and his lab at the State University of New York conducted an experiment in which scientists synthesized polio from its base pairs, which proved that a virus could be constructed from base chemicals, as The Conversation reports.
But this also carried a dark side: it meant that any virus could be constructed in this way, and people with bad intentions who had this knowledge could release this virus into the world.
This is a good (and terrifying) example of the dark side of biotechnology, which shows that on the other side of scientific progress there's always the risk that malicious people will use it for evil purposes.

WHO CREATED THE BIOTECHNOLOGY COLORS?
Polish chemist Pawel Kafarski is renowned as the person who developed a color code to differentiate the main areas of biotechnology. He has co-authored over 270 scientific papers.

Conclusion

Biotechnology is not just one thing but a rainbow of colors! In this article, we've looked at the various branches of biotechnology that currently exist and how they're categorized according to different colors.

For example, agricultural biotechnology is green like the earth and medical biotechnology is red like the color of blood.

By studying all the branches of biotechnology in greater detail, we've seen how interconnected they really are and how they depend on each other in order to solve the problems of the world.

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