There are several consideration to take into account when approaching synthetic biology, especially from a bioethical perspective. There are 3 different examples of synthetic biology below. Discuss what some of the potential issues are and some of the benefits of synthetic biology. You can use the questions below as a start for your discussion!

- What are the relevant facts? (Scientific, social, cultural, etc…)
- What are the biological/environmental concerns of the practice?
  Is it safe? How does it affect the researchers/ consumers? Is it sustainable?
- How is it relevant to our lives? How is the industry affected by this? Any possible side product?
- What are the relevant ethical considerations?
    - Respect, Fairness, Utility

Case 1

Vanilla flavoring comes from a compound known as vanillin that is extracted from the pods of the Vanilla orchid. Growing the Vanilla orchid is difficult and resource-consuming, so many pesticides are used to help it grow. Furthermore, vanillin is often synthesized from other hydrocarbons and lignin, according to a 2003 study conducted at the Institute for Food Research in the UK. In 2009, researchers found a way to use yeast to produce vanillin from sugar. Later that year, the organization Friends of the Earth sent a letter to many large ice cream manufacturers including Häagen-Dazs and Baskin-Robbins urging them against using synthetic biology-derived vanillin citing environmental concerns and safety.

Case 2

To fight off disease, humans have evolved an immune system. Bacteria lack a true immune system, so instead they use a system known as CRISPR. CRISPR, together with a protein known as Cas9, integrates short pieces of viral DNA into the bacteria's own genome to help it recognize when it comes under viral attack. In 2013, researchers managed to use CRISPR-Cas9 to integrate short pieces of synthetic DNA into the bacterial genome. This powerful technology has incredible potential in synthetic biology as it has new potential to permanently modify the human genome through germline editing (editing of sex cells). In 2015, a group of Chinese researchers tried to edit human embryos, and had a poor success rate. Since then, there has been an international moratorium on research on germline editing.

Case 3

In 1980, the US Supreme Court ruled in *Diamond v. Chakraborty* and again in 2010 that it was legal to patent genes and genetic material. The criteria for obtaining a gene patent are broad and overarching; it could be 1) a diagnostic invention, 2) a composition of matter, or 3) functional. *BRCA1* and *BRCA2* are two genes used in diagnosis of breast cancer. Patents used to detect the presence of these genes are covered under diagnosis. Compositions of matter include recombinant DNA and functional inventions are typically molecular regulators.