# Biotechnology - Unit 6 - Recombinant DNA Technology, Transformation, and Genetic Engineering

## Unit Focus

This unit will provide clarity on the course phenomenon of the "Glowing Axolotl" as students manipulate the genes of bacteria to insert a "glow gene". The unit will begin with an exploration of bacterial genetics including why bacteria are used extensively in biotechnology. Exploration of the bacterial chromosome and plasmids, operon structure and function, bacterial growth conditions/types of growth, and the importance of aseptic technique when working with bacteria will be emphasized. Students will also investigate the steps involved in the production of recombinant DNA, bacterial transformation, and selection of transformants. CRISPR Cas9 technology may also be introduced as a cutting edge technology for the creation of recombinant DNA. Students will be introduced to applications of recombinant DNA technology in the form of Genetically Modified Organisms (GMOs) for the creation of therapeutic compounds and other products and gene therapy.

## Stage 1: Desired Results - Key Understandings

### Standard(s)

**NGSS/NSTA Science & Engineering Practices**
NGSS Science & Engineering Practices: 9-12

- Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. (SE.9-12.1.1)
- Ask questions to clarify and refine a model, an explanation, or an engineering problem. (SE. 9-12.1.4)
- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (SE.9-12.4.1)
- Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. (SE.9-12.4.5)
- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (SE.9-12.6.2)
- Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects (SE.9-12.6.3)
- Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (SE.9-12.6.4)

**Next Generation Science Standards (DCI)**
Science: 10

### Transfer

*Students will be able to independently use their learning to...*
**T1** Analyze qualitative and quantitative data to interpret patterns, draw conclusions, and/or make predictions.

### Meaning

#### Understanding(s)

*Students will understand that...*
**U1** Genetic engineering allows scientists to transfer genes from one organisms in another and get the host organism to express that gene.
**U2** Established knowledge provides the foundation for future scientific and engineering advances.
**U3** Genetic engineering requires the use of a vector (plasmid or virus) to facilitate the transfer of genetic material to one organisms to another.

#### Essential Question(s)

*Students will keep considering...*
**Q1** What role do recombinant DNA technology, transformation, and genetic engineering play in explaining the anchoring phenomenon?
**Q2** How do humans manipulate characteristics of organisms? What is the impact?

### Acquisition of Knowledge and Skill

#### Knowledge

*Students will know...*
**K1** The difference between the main bacterial chromosome and a plasmid.
**K2** The structural design of plasmids and the purpose for which they are used.

#### Skill(s)

*Students will be skilled at...*
**S1** Interpreting the results of bacterial plating (lawn vs. colonies) and understand the implications of their observations.
**S2** Following lab protocols with precision.

## Stage 1: Desired Results - Key Understandings

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| • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (LS1.9.B1)<br>• Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species" characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (LS3.9.A1)<br>• In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (LS3.9.B1)<br><br>**Next Generation Science Standards (content standards)**<br>High School Life Sciences: 9 - 12<br>• Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. (HS-LS1-1)<br>• Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (HS-LS3-1)<br>• Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. (HS-LS3-2)<br><br>**Madison Public Schools Profile of a Graduate**<br>• Analyzing: Examining information/data/ evidence from multiple sources to identify possible underlying assumptions, patterns, and relationships in order to make inferences. (POG.1.2) | **K3** The structure/function of an operon and how they are exploited in the lab.<br>**K4** Why bacteria are extensively used in the field of biotechnology.<br>**K5** The many ways that bacteria can be grown in a lab (agar, broth, incubator, shaker, etc.), the types of growth that can occur (lawn, colony, suspension in broth, etc.), and in what circumstances each would be used.<br>**K6** The importance of aseptic technique.<br>**K7** The steps taken to produce a recombinant DNA molecule and why each step is performed.<br>**K8** The steps involved with bacterial transformation and methods for the selection of transformants, including but not limited to antibiotic resistance and GFP.<br>**K9** Practical applications of recombinant DNA technology including GMOs for the production of therapeutic compounds and other products, gene therapy, etc.<br>**K10** How CRISPR Cas9 is used and practical applications of the technology.<br>**K11** Vocabulary: recombinant DNA, transformation, bacterial chromosome, plasmid, restriction enzyme, ligase, gene of interest, operon, agar, broth, lawn, colony, aseptic technique, antibiotic resistance, GFP, competency, heat/cold shock, GMO, CRISPR Cas9 | |