Guide for Judging Biomedical/Health Sciences and Bioengineering Science Fair Projects

This guide provides an overview of two key categories: Biomedical/Health Sciences and Bioengineering, with subcategories highlighting the diverse approaches students may take in addressing health, disease, and engineering solutions in biology.

Biomedical/Health Sciences

Projects in Biomedical/Health Sciences should focus on human health, disease mechanisms, or factors that influence health outcomes. This includes studies on the diagnosis, treatment, prevention or epidemiology of disease and other damage to the human body or mental systems. Studies may investigate internal as well as external factors such as feedback mechanisms, stress or environmental impact on human health and disease. Key areas include:

1. **Cell, Organ, and Systems Physiology**
    - *Definition:* Studies that explore how physiological processes at the cellular, organ, or system levels maintain health or lead to disease when disrupted.
    - *Evaluation Criteria:*
        - Depth in understanding cell signaling, homeostasis, and physiology.
        - Clarity in explaining disease mechanisms or stress responses.
        - Innovation in research on biological processes or disease causes.
2. **Genetics and Molecular Biology of Disease**
    - *Definition:* Investigations into genetic and molecular pathways that regulate normal cellular functions or cause disease.
    - *Evaluation Criteria:*
        - Research on gene regulation, transcription factors, or epigenetics.
        - Relevance to understanding genetic diseases or molecular dysfunction.
        - Accuracy and depth in the analysis of genetic influences on disease.
3. **Immunology**
    - *Definition:* Studies of immune system function and how immune dysregulation can lead to disease.
    - *Evaluation Criteria:*
        - Investigation of immune responses, cell interactions, or signaling pathways.
        - Focus on immune dysfunctions like autoimmunity or immunodeficiency.
        - Practical applications to disease prevention or treatment.
4. **Nutrition and Natural Products**
    - *Definition:* Research on human dietary needs, nutrient effects, and the impact of natural supplements on health.
    - *Evaluation Criteria:*
        - Analysis of nutrient interactions and their physiological effects.
        - Novel insights into nutrition-related health outcomes or disease prevention.
        - Rigor in assessing nutritional or natural product effects on health.
5. **Pathophysiology**
    - *Definition:* Studies that identify disease causes and physiological processes underlying disease development.
    - *Evaluation Criteria:*
        - Insight into mechanisms disrupting normal physiological balance.
        - Innovation in exploring how stress or environmental factors impact disease.
        - Relevance to understanding disease progression or intervention points.

Bioengineering

Bioengineering projects involve the application of engineering principles and design concepts to medicine and biology for healthcare purposes including diagnosis, monitoring and therapy. Applications include the development of biocompatible prostheses, various diagnostic and therapeutic medical devices ranging from clinical equipment to micro-implants, common imaging equipment such as MRIs and EEGs, regenerative tissue growth, pharmaceutical drugs and therapeutic biologicals. Key areas include:

1. **Biomaterials and Regenerative Medicine**
    - *Definition:* Research on biocompatible materials or scaffolds supporting tissue regeneration or healing.
    - *Evaluation Criteria:*
        - Effectiveness of biomaterials in supporting regenerative growth.
        - Engineering precision in constructing viable tissue-support environments.
        - Practical application to wound healing or tissue repair.
2. **Biomechanics**
    - *Definition:* Application of mechanical principles to biological tissues and systems.
    - *Evaluation Criteria:*
        - Understanding of mechanics such as dynamics, fluid flow, and material deformation.
        - Innovation in solving biological or medical issues with mechanical solutions.
        - Application to medical devices or structural analysis of biological systems.
3. **Biomedical Devices**
    - *Definition:* Design and development of devices for disease prevention, diagnosis, or treatment.
    - *Evaluation Criteria:*
        - Functionality and innovation in device design for therapeutic use.
        - Practicality and reliability in treating or monitoring health conditions.
        - Consideration of user safety and biocompatibility.
4. **Biomedical Sensors and Imaging**
    - *Definition:* Devices or techniques for measuring body conditions through data collection and display.
    - *Evaluation Criteria:*
        - Innovation in using sound, radiation, or magnetism to capture data.
        - Accuracy and clarity in capturing and displaying health-related information.
        - Application potential to improve diagnostics or patient monitoring.
5. **Cell and Tissue Engineering**
    - *Definition:* Studies utilizing cellular mechanics to understand and intervene in disease.
    - *Evaluation Criteria:*
        - Depth of knowledge in cellular structures and their interactions.
        - Practical intervention methods for treating or understanding diseases.
        - Potential to innovate therapeutic approaches at the cellular level.
6. **Synthetic Biology**
    - *Definition:* Engineering of biological parts and systems, including genetic and protein engineering.
    - *Evaluation Criteria:*
        - Creativity and precision in designing biological circuits or engineered proteins.
        - Innovation in solving biological challenges with synthetic biology.
        - Relevance to advancing therapeutic or biotechnological applications.

In judging projects, look for a thorough understanding of biomedical or bioengineering principles, innovation in addressing health challenges, and real-world applicability. Projects should clearly demonstrate how the student applied scientific and engineering methods to achieve their objectives.