Genetics and Genomics Competencies for Clinical Investigators

Competency 1: Patterns of Genetic Transmission

Recognize the patterns of Mendelian and non-Mendelian genetic transmission as well as the characteristics of multifactorial inheritance in order to define the mode of genetic transmission of a trait.

Learning Objectives

1. Construct and analyze pedigrees to determine mode of inheritance and define penetrance of a phenotype.
2. Recognize instances of non-Mendelian inheritance, such as mitochondrial inheritance, genomic imprinting effects, epistasis, *etc*.
3. Identify instances of multifactorial inheritance and determine heritability of a trait.
4. Utilize databases of human genetic traits, such as Online Mendelian Inheritance in Man

Competency 2: Genome Structure and Function

Use knowledge of the structure and function of individual genes and the human genome to identify genes responsible for rare and common disorders and study the pathophysiology of these disorders.

Learning Objectives

1. Describe the functional elements of the human genome and major technologies available to characterize them in human samples.
2. Describe the major forms of human genetic variation (*e.g.,* nucleotide changes to copy number changes) and the technologies available to detect them.
3. Describe the use of bioinformatics databases to analyze sequence information and interpret the significance of genetic variants.
4. Explain how model systems can be used to elucidate the functional significance of genetic variants.
5. Describe the difference between germline and somatic genetic changes and the approaches used to characterize the latter.
6. Explain the concept of epigenetics and the role of environmental exposures in modifying patterns of gene expression.

Competency 3: Population and Statistical Genetics

Use the principles of population genetics to define the genetic contribution to rare and common disorders and devise genetic epidemiological studies to identify the relevant genetic factors.

Learning Objectives

1. Utilize the principles of genetic linkage to devise a linkage-based approach to map a genetic locus.

2. Explain how consanguinity mapping and studies of admixture can be helpful in gene localization.
3. Devise an approach to elucidation of genetic contributions to multifactorial traits based on genome-wide association or transmission disequilibrium studies.
4. Describe the pitfalls in interpretation of genetic epidemiological studies and how to avoid them.

Competency 4: Medical Applications of Genetics and Genomics

Explain how advances in genetics and genomics can be translated into new approaches to risk assessment, diagnosis, and treatment.

Learning Objectives

1. Calculate genetic risks based on analysis of pedigree information.
2. Calculate the odds of common disorders based on genetic association studies and explain the pitfalls in the use of these data.
3. Explain how a clinical genetic test is developed from a research laboratory finding, including the principles of analytical validity, clinical validity, and clinical utility.
4. Describe the regulatory requirements that must be met to provide clinical reporting of the results of a genetic test.
5. Explain how genetic discoveries can be translated to new therapeutic approaches, including the pathway from the laboratory to preclinical testing to clinical trials.
6. Describe how pharmacogenetic information can be used to guide clinical decision-making.

Competency 5: Ethical, Legal, and Social Issues

Demonstrate awareness of the major ethical, legal, and social issues that must be considered in the design of genetic and genomic research studies that involve human participants.

Learning Objectives

1. Describe the aspects of informed consent that must be taken into consideration in recruitment of participants for genetic and genomic studies, *e.g.* issues of privacy, involvement of family members, discovery of misattributed parentage, *etc.*
2. Explain how state and federal laws offer protection against "genetic discrimination," and the limitations of such laws.
3. Describe the application of intellectual property and patent laws to genes and gene sequences.
4. Explain how large communities can be approached and engaged in participation in genetic and genomic studies.