Certified Specialist Programme in Next-Generation Sequencing

# Clinical Applications of NGS

Next-generation sequencing (NGS) has revolutionized the field of molecular biology and genomics. The clinical applications of NGS are vast and continue to expand as technology improves. In this explanation, we will discuss key terms and vocabulary related to the clinical applications of NGS in the Certified Specialist Programme.

1. Next-generation sequencing (NGS): NGS is a high-throughput technology that allows for the sequencing of large amounts of DNA or RNA in a short amount of time. It has replaced traditional Sanger sequencing, which is slower and less efficient.
2. Genome: A genome is the complete set of genetic information contained within an organism. It includes all of the genes and regulatory regions that are necessary for the organism to function.
3. Exome: The exome is the portion of the genome that encodes proteins. It makes up only about 1-2% of the genome, but it is responsible for many genetic diseases.
4. Genetic variant: A genetic variant is a difference in the DNA sequence between individuals. Variants can be benign, harmful, or of unknown significance.
5. Single nucleotide variant (SNV): A single nucleotide variant is a type of genetic variant that involves the substitution of one nucleotide for another.
6. Insertion/deletion variant (INDEL): An insertion/deletion variant is a type of genetic variant that involves the addition or deletion of one or more nucleotides.
7. Copy number variant (CNV): A copy number variant is a type of genetic variant that involves the gain or loss of a segment of DNA.
8. Genetic testing: Genetic testing is the analysis of an individual's DNA to identify genetic variants that may be associated with a particular disease or condition.
9. Clinical sequencing: Clinical sequencing is the use of NGS technology to perform genetic testing in a clinical setting. It is used to diagnose genetic diseases, guide treatment decisions, and assess an individual's risk of developing a particular disease.
10. Variant of uncertain significance (VUS): A variant of uncertain significance is a genetic variant for which the clinical significance is unknown.
11. Bioinformatics: Bioinformatics is the field of study that deals with the collection, storage, analysis, and interpretation of biological data, including genetic data.
12. Allele frequency: Allele frequency is the frequency of a particular genetic variant in a population.
13. Population genetics: Population genetics is the study of the distribution and frequency of genetic variants within populations.
14. Phylogenetics: Phylogenetics is the study of the evolutionary relationships among organisms based on their genetic data.
15. Genome-wide association study (GWAS): A genome-wide association study is an observational study that identifies genetic variants that are associated with a particular trait or disease.
16. Whole exome sequencing (WES): Whole exome sequencing is a type of sequencing that focuses on the

exome, the portion of the genome that encodes proteins.
17. Whole genome sequencing (WGS): Whole genome sequencing is a type of sequencing that sequences the entire genome, including both coding and non-coding regions.
18. RNA sequencing (RNA-seq): RNA sequencing is a type of sequencing that measures the expression levels of genes in a sample.
19. Transcriptome: The transcriptome is the complete set of RNA molecules that are expressed in a particular cell or tissue at a given time.
20. Variant calling: Variant calling is the process of identifying genetic variants in NGS data.
21. Variant interpretation: Variant interpretation is the process of determining the clinical significance of a genetic variant.
22. Clinical annotation: Clinical annotation is the process of adding clinical information to genetic variants.
23. Clinical decision support: Clinical decision support is the use of technology to assist healthcare providers in making clinical decisions.
24. Ethical, legal, and social implications (ELSI): Ethical, legal, and social implications are the potential consequences of genetic testing and NGS technology.
25. Data security: Data security is the protection of genetic data from unauthorized access, use, or disclosure.

Clinical applications of NGS include:

1. Diagnosis of genetic diseases: NGS can be used to identify genetic variants that are associated with genetic diseases, such as cystic fibrosis, sickle cell anemia, and Huntington's disease.
2. Guiding treatment decisions: NGS can be used to identify genetic variants that are associated with drug responses, allowing healthcare providers to make more informed treatment decisions.
3. Assessing disease risk: NGS can be used to identify genetic variants that are associated with an increased risk of developing a particular disease, such as cancer or heart disease.
4. Prenatal testing: NGS can be used to identify genetic variants in fetuses, allowing for early detection and intervention for genetic diseases.
5. Carrier screening: NGS can be used to identify genetic variants in individuals who are carriers of genetic diseases, allowing them to make informed reproductive decisions.
6. Pharmacogenomics: NGS can be used to identify genetic variants that are associated with drug responses, allowing for personalized medicine and improved patient outcomes.
7. Cancer genomics: NGS can be used to identify genetic variants in cancer cells, allowing for the development of targeted therapies and improved patient outcomes.
8. Microbial genomics: NGS can be used to identify genetic variants in microorganisms, allowing for the development of targeted therapies and improved public health outcomes.
9. Agricultural genomics: NGS can be used to identify genetic variants in crops and livestock, allowing for the development of improved varieties and increased food security.

Challenges in clinical applications of NGS include:

1. Data analysis and interpretation: NGS generates large amounts of data, and the interpretation of this data can be challenging.

2. Variant calling and interpretation: Identifying and interpreting genetic variants can be difficult, particularly when it comes to variants of uncertain significance.
3. Ethical, legal, and social implications: Genetic testing and NGS technology raise a number of ethical, legal, and social issues, including privacy concerns, discrimination, and informed consent.
4. Data security: Protecting genetic data from unauthorized access, use, or disclosure is a major concern in clinical applications of NGS.
5. Cost: NGS can be expensive, and the cost of sequencing can be a barrier to access for some individuals.
6. Turnaround time: NGS can be time-consuming, and the turnaround time for results can be lengthy, which can be a challenge in clinical settings.
7. Access: Not all healthcare providers have access to NGS technology, and not all patients have access to genetic counseling and other support services.
8. Reimbursement: Reimbursement for NGS testing and other genetic services can be a challenge, particularly in the United States.
9. Education and training: Healthcare providers need education and training in genetics and NGS technology in order to effectively use this technology in clinical settings.

In conclusion, NGS technology has vast clinical applications, including the diagnosis of genetic diseases, guiding treatment decisions, assessing disease risk, prenatal testing, carrier screening, pharmacogenomics, cancer genomics, microbial genomics, and agricultural genomics. However, there are also challenges in the clinical applications of NGS, including data analysis and interpretation, variant calling and interpretation, ethical, legal, and social implications, data security, cost, turnaround time, access, reimbursement, and education and training. It is important for healthcare providers to understand these key terms and concepts in order to effectively use NGS technology in clinical settings.