Cytogenetics - Technologies, Markets and Companies

Description:
This report deals with cytogenetics in a broader sense rather than the classical use mainly to describe the chromosome structure and identify abnormalities related to disease. In the age of molecular biology, it is also referred to as molecular cytogenetics. Historical landmarks in the evolution of cytogenetics are reviewed since the first images of chromosomes were made in 1879. The scope of cytogenetics includes several technologies besides fluorescence in situ hybridization (FISH), comparative genomic hybridization (CGH), and multicolor FISH. Molecular cytogenetics includes application of nanobiotechnology, microarrays, real-time polymerase chain reaction (PCR), in vivo imaging, and single molecule detection. Bioinformatics is described briefly as it plays an important role in analyzing data from many of these technologies.

FISH remains the single most important technology in cytogenetics. Several innovations are described of which the most important are single copy FISH, in vivo FISH (imaging of nucleic acids in living cells) and nanotechnology-based FISH. The unique character of peptide nucleic acid (PNA) allows these probes to hybridize to target nucleic acid molecules more rapidly and with higher affinity and specificity compared with DNA probes. PNA-FISH is more suited for rapid diagnosis of infections. RNA-FISH and locked nucleic acids (LNAs), are also described.

Microarray/biochip-based technologies for cytogenetics promise to speed up detection of chromosome aberrations now examined by FISH. Other important genomic technologies are whole genome expression array and direct molecular analysis without amplification. Analysis of single-cell gene expression promises a more precise understanding of human disease pathogenesis and has important diagnostic applications. Optical Mapping can survey entire human genomes for insertions/deletions, which account for a significantly greater proportion of genetic variation between closely-related genomes as compared to single nucleotide polymorphisms (SNPs), and are a major cause of gene defects.

Technologies encompassed within molecular imaging include optical imaging, magnetic resonance imaging (MRI) and nuclear medicine techniques. Positron emission tomography (PET) is the most sensitive and specific technique for imaging molecular pathways in vivo in humans. Cytogenetics can be refined by application of cytogenetics at single molecule level. Nanotechnology has facilitated the development of technology for single molecule imaging. Atomic force microscope (AFM) has become a well-established technique for imaging single biomolecules under physiological conditions. The scanning probe microscope (SPM) system is emerging as an increasingly important tool for non-intrusive interrogation of biomolecular systems in vitro and have been applied to improve FISH. Another example of application of nanobiotechnology is QD (quantum dot)-FISH probes, which can detect down to the single molecule level.

There are connections between cytogenetics and biomarkers of genetic disorders as well as cancer. Biomarkers are very important for molecular diagnostics. Not only are molecular diagnostic technologies used for discovery of biomarkers, biomarkers are the basis of several diagnostics. As a means to understand pathomechanism of disease and as links between diagnostics and therapeutics, biomarkers are playing a role in development of personalized medicine. Application of cytogenetics extend beyond genetic disorder and cancer to diagnosis of several other diseases. Other important applications are drug discovery, and development of personalized medicine.

The chapter on markets provides a global perspective of the cytogenetics business in the major markets: US, Western Europe (including France, Germany, Italy, Spain, and the UK), and Japan. The total figures for the market are also broken out according to the technologies and major disease areas in which they are applied. Markets figure are given for the year 2016 and estimates are made for the years 2021 and 2026. Advantages and limitations of various technologies have been pointed out throughout the report but this chapter includes SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of some of the competing technologies including the following: conventional FISH, innovative FISH technologies, PCR-based assays, and single molecule imaging. Unfulfilled needs in cytogenetics market are depicted graphically. Among various technologies, FISH is most advanced and less opportunities for further development than single molecule detection, which is in infancy and has more future potential.

The report includes summary profiles of 69 companies relevant to cytogenetics along with their 80 collaborations. Companies developing innovative technologies as well as those supplying equipment/services/reagents are identified. The report text is supplemented with 27 Tables and 9 figures.
Selected 200 references are included in the bibliography.

The following areas are covered in this report:

- Introduction to cytogenetics
- Technologies used for cytogenetics
- Fluorescent in situ hybridization
- Genomic technologies relevant to cytogenetics
- Molecular imaging and single molecular detection
- Role of nanobiotechnology in cytogenetics
- Biomarkers and cytogenetics
- Applications of cytogenetics
- Cancer cytogenetics
- Markets for cytogenetics
- Companies

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