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# Techniques for Cytogenetic Analysis

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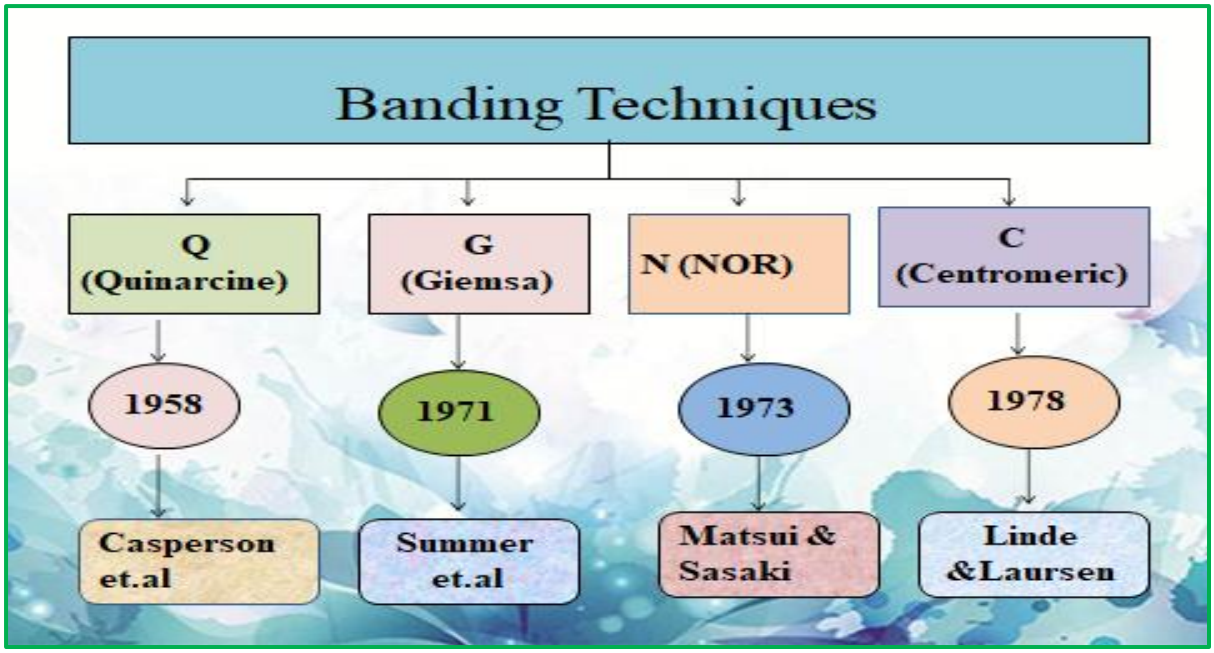
The constituent part of a cell's nucleus known as chromosomes carries the DNA-based genes which make up the individual's hereditary genetic material. The term "chromosome" is derived from the Greek language and means "colour (chromo)-body (some)" due to their intense staining with certain dyes. A variety of banding techniques developed between 1960 and 1970, including quinacrine fluorescent staining (Q-banding), centromeric banding (C-banding), and giemsa banding (G-banding), have been widely used in clinical laboratories worldwide for karyotyping and detecting constitutive chromosomal aberrations. Since the early 1970s, many molecular cytogenetic techniques using non-fluorescent and fluorescent in situ hybridization (FISH) have been developed in addition to these fundamental methods. Cytological maps are developed by microscopic determination of the location of visible structures on fixed and stained chromosomes. A cytogenetic map would make it possible to correlate molecular markers with the higher level of chromosomal organisation. Studies of the structure of the genome and its relationship to chromatin now inevitably include cytogenetic methods.

## Cytogenetic banding techniques

Potential landmarks are the unique and reproducible bands that result from staining chromosomes with various types of dyes, e.g. Q-banding (quinacrine mustard, stains AT-rich regions), G-banding (G=giemsa, stains AT-rich heterochromatin), C-banding (C=constitutive, stains centromeric regions). The nucleolar organizing regions (NORs) are regions of euchromatin and non-centric heterochromatin regions such as knobs and chromomeres. The N-banding method, which was created in 1973 by Matsui and Sasaki using silver nitrate and ammoniacal silver solution, involves the extraction of histones, RNA, and DNA. In the case of humans and animals, G-banding has become recognised as a popular technique to precisely identify the homologous pair of chromosomes (Sumner et al., 1971). Q-banding is useful in many cases and can be used for identification of many chromosomal aberrations, such as trisomy, monosomy, fusion, reciprocal translocation, and deletion. The C-bands are often found in the centromeric and paracentromeric regions of mammals, and they are also frequently seen in telomeric, interstitial, and even whole-arm distributions. The *W* chromosomes of birds and the *Y* chromosomes of many mammalian species may both be identified using the C-banding technique. The Giemsa stain's R-banding displays a pattern that is the opposite of G-bands. The darkly stained G-bands are lightly stained in R-band preparations and vice versa.




**Banding techniques and the leading scientists who study them**

**Fluorescence in situ hybridization (FISH):** The extensive use of this technology was made possible by the replacement of radioactivity with fluorescent DNA probes. FISH is superior to traditional approaches in a number of ways, including analytical speed, sensitivity, stability, safety and resolution. Additionally, FISH employing probes either for chromosome-specific regions or entire chromosomes has made it much easier and more precise to analyze numerical and structural chromosomal aberrations than the time-consuming and labour-intensive G-banding approach. For multicoloured FISH, there are two techniques. In the indirect technique, dinitrophenol (DNP), digoxigenin, and biotin are used as reporter molecules. Fluorescence-conjugated avidin or antibodies are used to find them. In the direct technique, probe labelling is carried out using fluorochrome-labelled nucleotides.

**Cytogenetic maps:** As the name suggests, cytogenetic maps combine information from genetic maps with actual cytological characteristics of chromosomes including centromeres, knobs, and, more recently, fluorescence in situ hybridization (FISH) signals. Classical cytological studies using chromatin staining greatly contribute to understanding chromosomal diversity in wild species.

This approach provides an overview of chromosomal behaviour during mitosis and meiosis andenables the identification of numerous karyotypic modifications, such as changes in chro mosome number and form.

## Future prospects

Cytogenetic maps have many kinds of useful applications for researchers. These maps can also be used to better answer particular biological questions related to meiotic processes, such as recombination and meiotic homologue pairing. Additionally, a cytogenetic map will permit the placement of markers that cannot be mapped by recombination-based techniques (i.e., genetically). The primary use of chromosomal banding, both from an evolutionary perspective that is more basic and from a more practical production perspective is demanding. The field of radiation biodosimetry, which tracks the absorbed radiation dosage in either occupationally or accidentally exposed persons, is one particular area where cytogenetics is being employed extensively.

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