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A COMPREHENSIVE STUDY OF MOLECULAR HYBRIDIZATION TECHNIQUES IN CYTOGENETICS WITH A FOCUS ON CHRONIC MYELOID LEUKAEMIA

Abstract: Early and accurate diagnosis of chromosomal abnormalities is crucial for preventing congenital disorders. However, cytogenetics faces limitations in Ukraine, likely due to a lack of specialists and public awareness. This study aims to investigate these limitations and explore strategies to promote cytogenetics in Ukraine. By increasing access and awareness, more people can benefit from this potentially life-saving field.

Key words: cytogenetics, Chronic myeloid leukaemia, molecular hybridization techniques, analysis, treatment.

Cytogenetics is a fundamental study of chromosomes when they're become visible during the cell division processes either mitosis or meiosis, depending on what should be analysed. [5] This is a fundamental approach in medical genetics as it can be used in many areas that require analysis of the genome such as cancer diagnosis and treatment, prenatal diagnosis, infertility studies, genetic counselling, etc [6].

These techniques can be used in many different ways as it depends on the task was given to perform the analysis. It would be necessary to pick exact ones to describe in this report, so taking into consideration all factors Chronic Myeloid Leukaemia has been chosen as an example in order to demonstrate some of them for better explanation, clarification and detailed protocols of usage. Therefore, in this report will be discussed: chromosome banding techniques, Karyotyping Fluorescence In Situ Hybridization (FISH), Comparative Genomic Hybridization (CGH), Array-Based Comparative Genomic Hybridization (aCGH), Spectral Karyotyping (SKY), Multiplex FISH (M-FISH), Chromosome Microdissection and Reverse Painting, Southern Blotting, Pulsed-Field Gel Electrophoresis (PFGE), Quantitative Fluorescent PCR (QF-PCR). As has been mentioned earlier, some of the techniques will be demonstrated on the example of Chronic Myeloid Leukaemia [11, 10, 7].

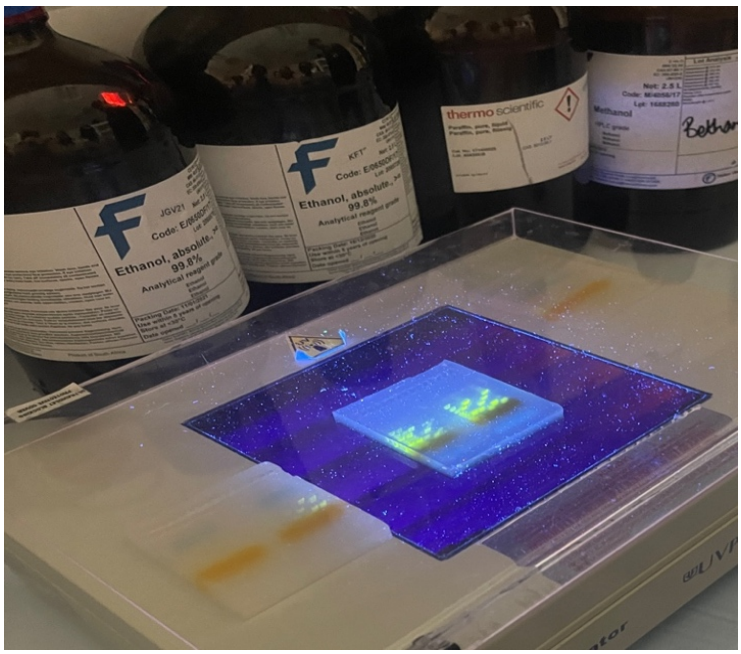

Fig. 1. DNA Analysis using Gel Electrophoresis

Chronic Myeloid Leukaemia (CML) is a type of Chronic leukaemia that is caused by a partial translocation that affects granulocytes. CML cells make other cells to mature only partially and therefore these abnormal premature simply cannot work properly and effectively weakening the immune system. The most common cause of CML is a chromosome translocation that results in a Philadelphia chromosome (Ph chromosome or t (9;22) (q34; q11) translocation). Person with CML is more vulnerable to infections because

of the weakened immune system, thrombocytopaenia, leukopenia; poor wound healing, more frequent and easier bleeding are the symptoms of CML. The lab investigations for people with CML usually begins with a blood smear with a Complete Blood Count (CBC); however, the necessity of the further investigations such as genetic testing for Philadelphia chromosome appears almost immediately. Treatment for CML includes targeted therapy using tyrosine kinase inhibitors (TKIs) like imatinib that could specifically inhibit the BCR-ABL tyrosine kinase, the abnormal protein produced by the Philadelphia chromosome [9, 12, 8].

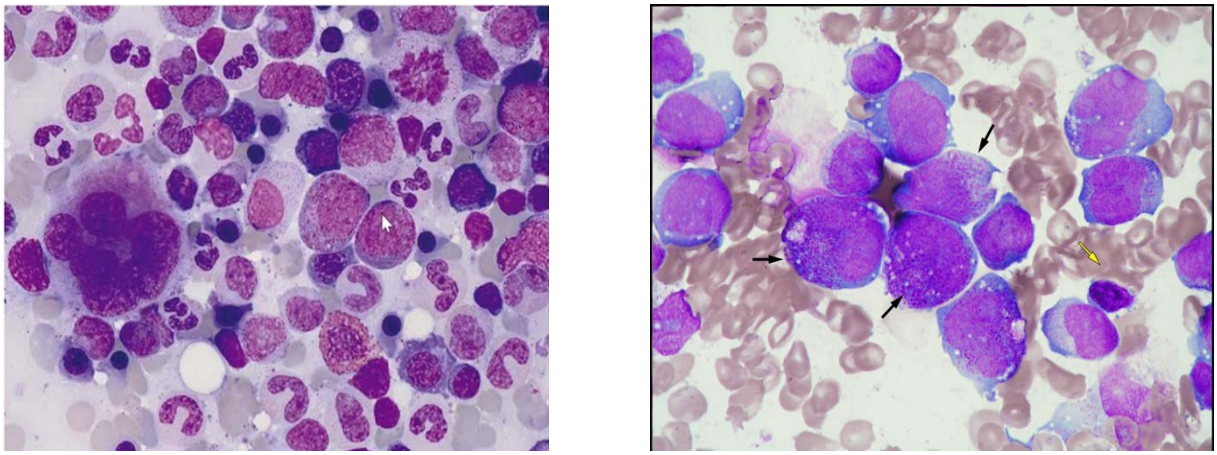

Fig. 2. Normal Bone Marrow (BM) vs CML [1, 3]

It is worth to note that it is possible not only diagnose CML using cytogenetic techniques but also monitor the treatment response and its efficacy, types of the treatment that will be suitable for a particular person, etc. Next point is scopes and limitations of the current cytogenetics techniques, that include economic accessibility, ethical considerations, specialists to interpret the results, resolution and targeted probes using FISH that means that only known sequences can be recognised nowadays [2].

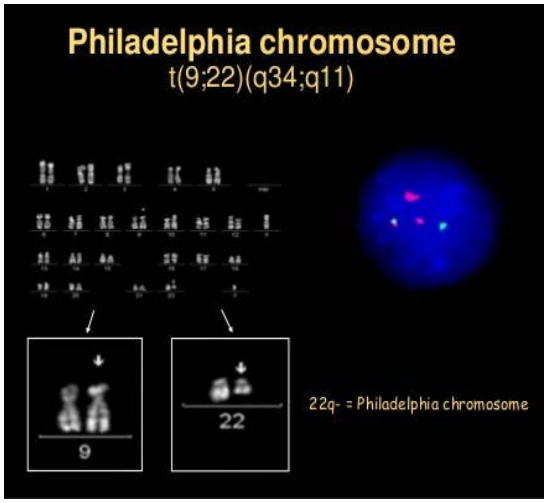

Fig. 3. Demonstration of the Philadelphia chromosome [4]

Consequently, cytogenetics is a crucial 'chapter' in biomedical sciences and medicine as it expands the possibilities of diagnosing and discovering new disorders. It is a 'root' in initiation of the usage of gene therapy in order treat genetic disorders as now it is a limited number of disorders that can be treated. Cytogenetics can also be used in prenatal diagnostics that is essential when dealing with disorders such as 21 trisomy, 18 trisomy. As they're diagnosed before birth parents can prepare for the possible outcomes to easier overcome that.

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