Quantum-Dot-Based Measurement of Gene Expression

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We propose a new, highly sensitive, high-throughput mechanism for measuring gene expression using gene transcripts barcoded with quantum dots. Accurate, high-throughput measurements of gene expression are crucial for many biomedical, biotechnology, and scientific applications. However, existing mechanisms such as gene chips, Reverse Transcriptase Polymerase Chain Reaction (RT-PCR), and Serial Analysis of Gene Expression (SAGE) do not offer a single satisfying solution.

Our novel approach for measuring gene expression utilizes a new computer algorithm to generate a unique barcode for each gene transcript. The algorithm automatically selects a library of 20-mer oligonucleotides complimentary to carefully chosen gene regions and assigns each oligonucleotide a specific color. The barcode scheme ensures that any given gene of interest will be hybridized with a unique set of colors. Based on the algorithm's output, we synthesize the different oligonucleotides and tag them with quantum dots of the appropriate fluorescence. We extract messenger RNA (mRNA) from the cells under study, reverse transcribe the mRNA into cDNA, and hybridize the cDNA with the tagged oligonucleotides.

The above process results in a set of gene products each labeled with a unique set of colors. An integrated microfluidic device placed under a microscope detects the barcoded DNA using Near Field Optics, a single UV laser, and a set of photo-detectors with appropriate filters. The small size and high intensity of the quantum dots provide an important accuracy advantage over existing approaches by allowing us to quantify single mRNA transcripts, potentially extracted from single cells. As a result, our approach does not require PCR amplification which typically distorts the distribution of the original transcripts. We will present our barcoding algorithm and preliminary experimental results of reading barcoded DNA using the integrated microfluidic device and standard optical detectors.