

I. Lateral-Flow Chromatographic Immunoassay
Cassettes and Devices for Detecting and Interpreting
Results of a Lateral-Flow Chromatographic
Immunoassay

[0021] Referring to FIG. 1, a typical lateral-flow chromatographic immunoassay cassette **100** is illustrated. The lateral-flow chromatographic immunoassay cassette **100** includes a plastic housing **130** containing a test strip, which is generally a plastic strip laminated with porous material that permits lateral flow of liquid. The illustrated lateral-flow chromatographic immunoassay cassette **100** includes a sample application zone **110** and an analysis zone **120**.

[0022] In one type of lateral-flow chromatographic immunoassay cassette, the test strip is divided into four domains, which can be made of only one kind of material or several kinds of material (e.g., up to four different kinds of materials). The first domain is for sample addition. It functions to remove viscous and particulate materials in the sample and also to condition the sample solution for the reactions in the following domains. The second domain is a mobile-phase with a color conjugate. In one embodiment, the color conjugate may be made from conjugation between a visible color marker (e.g., colored beads, colloidal gold, fluorescent dyes, etc.) and a detection antibody. The detection antibody can bind a specific antigen in the sample (e.g., an analyte of interest or a positive control substance) and forms an antigen-color conjugate complex. The third domain of the lateral-flow chromatographic immunoassay cassette is a solid-phase with immobilized capture antibody. The capture antibody can bind the antigen of the antigen-color conjugate complex and forms capture antibody-antigen-color conjugate complex sandwich. The fourth domain is for solution absorption. It draws sample solution towards it continuously.

[0023] During the testing, sample added to the first domain flows to the second domain. If the antigen is present in the sample, it will bind the color conjugate to form antigen-color conjugate complex. This complex then migrates to the third domain to bind the capture antibody and forms the capture antibody-antigen-color conjugate complex sandwich. Since the capture antibody is immobilized in the third domain, the sandwich shows as a visible color signal or a fluorescent signal, depending on the dye type, on the site of the capture antibody. If there is no antigen in the sample, no sandwich can be formed and hence no visible color signal can be seen in the third domain. This is a so-called non-competitive immunoassay or a sandwich assay where the amount of signal is directly proportional to the concentration of the analyte of interest in the sample.

[0024] Lateral-flow chromatographic immunoassay cassettes can also be adapted for competitive immunoassays. In a competitive immunoassay, the analyte of interest in the unknown sample competes for binding to an antibody with a labeled analyte. In a competitive assay, the labeled analyte is able to provide a known signal. In the assay, the amount of labeled analyte bound to the antibody is measured and any reduction in the known signal is attributed to the presence of the analyte in the sample. That is, in this method, the response will be inversely related to the concentration of analyte in the unknown. This is because the greater the response, the less antigen in the unknown was available to compete with the labeled antigen.

[0025] Lateral-flow chromatographic immunoassay cassettes may be adapted for assaying a number of different analyte types. For example, immunoassay cassettes have

been adapted or may in the future be adapted for blood glucose testing, metabolic testing (e.g., thyroid stimulating hormone), blood gas and electrolytes analysis, rapid coagulation testing, rapid cardiac markers diagnostics, drugs of abuse screening, urine testing, pregnancy testing, fecal occult blood analysis, food pathogen screening, complete blood count ("CBC"), hemoglobin diagnostics, infectious disease testing, cholesterol screening, hormone testing, cardiac pulmonary, gastroenterology, urology, dermatology, neurology, pediatrics, surgical, public health, and veterinary and plant pathology testing, combinations thereof, and the like.

[0026] Referring now to FIG. 2, a perspective view of a diagnostic test system **200** is illustrated. The diagnostic test system **200** includes a lateral-flow chromatographic assay cassette **205** and means for collecting assay data from the lateral-flow chromatographic assay cassette **205**.

[0027] The lateral-flow chromatographic assay cassette **205** includes a plastic housing **207** containing a test strip, which is generally a plastic strip laminated with porous material that permits lateral flow of liquid. The illustrated lateral-flow chromatographic immunoassay cassette **205** includes a sample application zone **210** and an analysis zone **230**.

[0028] When a sample **220** is applied to the lateral-flow chromatographic immunoassay cassette **205** at the sample application zone **210**, the sample **220** diffuses through the strip in flow direction **225** toward the analysis zone **230**. In the embodiment illustrated in FIG. 2, the analysis zone **230** includes a test line **240** that includes at least one capture ligand selected for capturing at least one analyte of interest in the sample **220**. The analysis zone **230** further includes at least first and second calibration standard lines **250** and **254**. Additionally, the analysis zone may include a positive control line **270** that may be configured to provide an indication regarding whether or not sample has diffused through the strip and whether or not the assay is functioning.

[0029] The analyte(s) of interest, the first and second calibration standards, and the positive control can be detected on their various target lines, **252**, **250**, **254** and **270**, respectively, with various reporters. The reporters **260-264** for each of the various target lines, **252**, **250**, and **254** may be the same or different. Examples of suitable reporters include, but are not limited to, visible and fluorescent dyes, latex beads, enzymes, gold nanoparticles, silver nanoparticles, quantum dots, and the like. Quantum dots are nano-scale materials that can produce excited emission at particular wavelengths depending on their size and shape. Quantum dots can be used in immunoassays where dyes have traditionally been used. However, quantum dots are generally superior to traditional organic dyes on several counts: quantum dots are typically much brighter than organic dyes (owing to their high extinction coefficients combined with a comparable quantum yield to fluorescent dyes) as well as their stability (i.e., much less photobleaching). For example, it has been estimated that quantum dots are 20 times brighter and 100 times more stable than traditional fluorescent reporters.

[0030] Emission from the various reporters can be excited by a number of sources. In the illustrated embodiment, an LED light source **280** is used illuminate the analysis zone **230** of the lateral flow assay cassette **205**. Illumination by the light source **280** may produce a detectable signal that includes at least one of emission (e.g., fluorescence), color, reflectance, diffuse scattering (i.e., scattering and absorbance), elastic light scattering, chemiluminescence, chemifluorescence, transmission, or absorbance from the reporters. A lens **290**