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Paper A

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Content (4 pages „Client‘s letter“) only available on screen during the examination

Contentu (4 pages „Lettre du client“) uniquement visible sue l‘écran pendant l‘examen

Client’s drawings

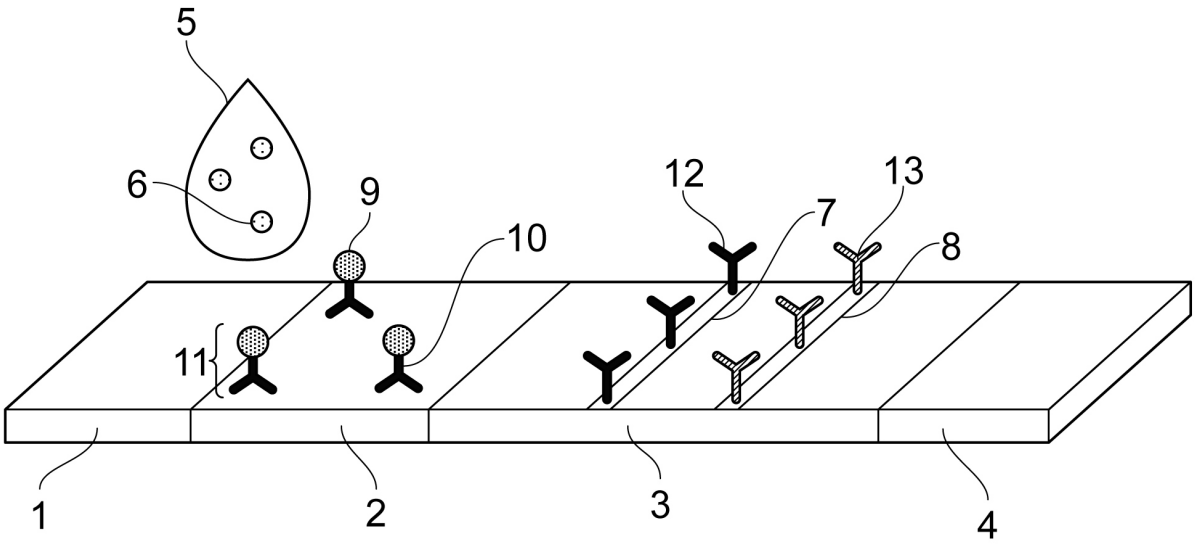

FIG. 1A

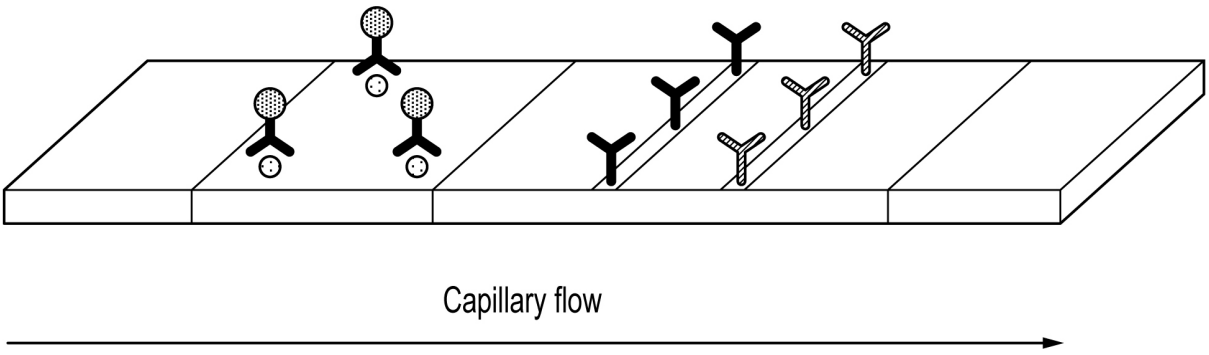

FIG. 1B

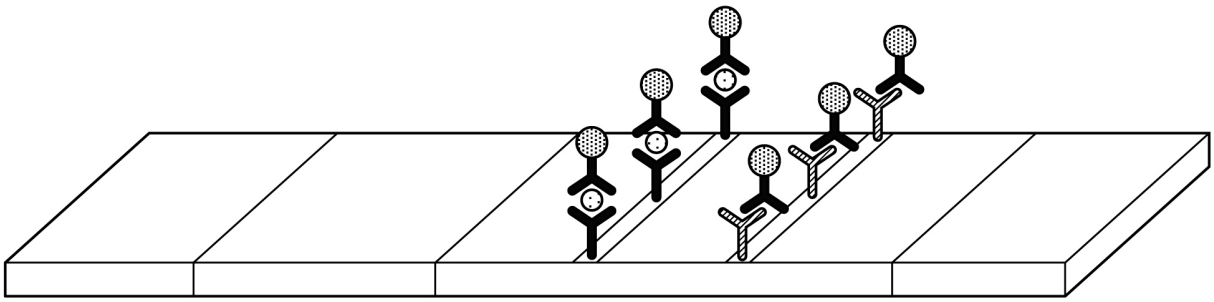

FIG. 1C

Excerpt from article: “Pregnancy Testing Through the Ages”

[001] For thousands of years, cultures have recognised that clues to whether a woman is pregnant could be discovered by inspecting her urine. By the early twentieth century, researchers realised that a woman’s body produces a hormone called human chorionic gonadotropin (hCG) after an egg is fertilised, and that this hormone is present in her urine.

[002] By the late 1970s the first pregnancy kits for home use were approved by the U.S. Food & Drug Administration. These kits required users to mix urine with solutions in test tubes and wait two hours for a result. In addition to being difficult to use, there was a high percentage of false negatives and so the results were not always reliable.

[003] The major breakthrough came in the 1990s with the development of lateral flow tests. A significant advantage is their simplicity of use, and the ability to produce a result within minutes that can be read with the naked eye. As many will know, the result is displayed as a coloured line, but how is this coloured line formed?

[004] As shown in Figure A, a lateral flow pregnancy test works by collecting a sample of urine on a sample pad (1). The urine runs along the test strip to the conjugate zone (2), which contains a detection agent (9) that reacts to a target molecule in the urine. This reaction then leads to a visible change that indicates a positive test.

[005] Lateral flow tests rely on the interaction between an antibody and its target. Antibodies are ‘Y’ shaped proteins with two arms that specifically recognise other molecules and bind to them. An antibody which is specific for a certain molecule will bind only to that molecule and not to any others. Therefore, the use of antibodies in these tests allows for highly specific detection of a target molecule.

[006] The conjugate zone contains antibodies (8) that are specific to the hCG hormone. The antibodies are attached to small, blue-coloured latex particles (7). The antibody-latex conjugates are held in the conjugate zone in a dry state. If hCG is present in the urine sample, it binds to the conjugates and flows down the strip towards the test line (5) in the reaction zone (3).

[007] At the test line (5) there are more hCG-specific antibodies (10), but these ones are fixed to the strip. These fixed antibodies capture the hCG attached to the blue latex particles. This creates the blue line seen on these pregnancy tests.

[008] The reaction zone also contains a second line of fixed antibodies (11). These antibodies capture surplus conjugate not bound to hCG. This acts as a control line (6), showing that the test has been completed properly, and so is at the end of the test furthest away from the sample addition pad. Although the control line is a common feature of most commercially available pregnancy tests, there are some tests available that do not include one and rely on other means to show that the test has been performed successfully.

[009] The final part of the test is the wick (4) that absorbs the excess liquid sample. The wick (4) is made from an absorbent material such as cotton, cellulose filter or glass fibre. The pregnancy test is contained in a plastic cassette with labels to show where the test and control lines are located to help the user to read the test result.

[010] An important feature of the test is the material used for the strip containing the reaction zone (3). The best results are obtained with a nitrocellulose membrane that has a pore size of 9-10 microns. Other materials commonly used in these pregnancy tests include cellulose fibre for the sample pad (1) and non-woven glass fibre for the conjugate zone (2).

[011] To maximise sensitivity of the pregnancy test it is important to use antibodies that will bind strongly to the hCG hormone, preferably with a binding affinity (K_D) $\leq 10^{-7}$M.

[012] Since the 1990s, lateral flow tests have been developed for many different applications, such as detection of viral and bacterial molecules to diagnose infection, and can test a variety of samples including blood, saliva, and nasal and throat swabs. When testing nose and throat swab samples, these are usually first suspended in an extraction solution of phosphate buffered saline.

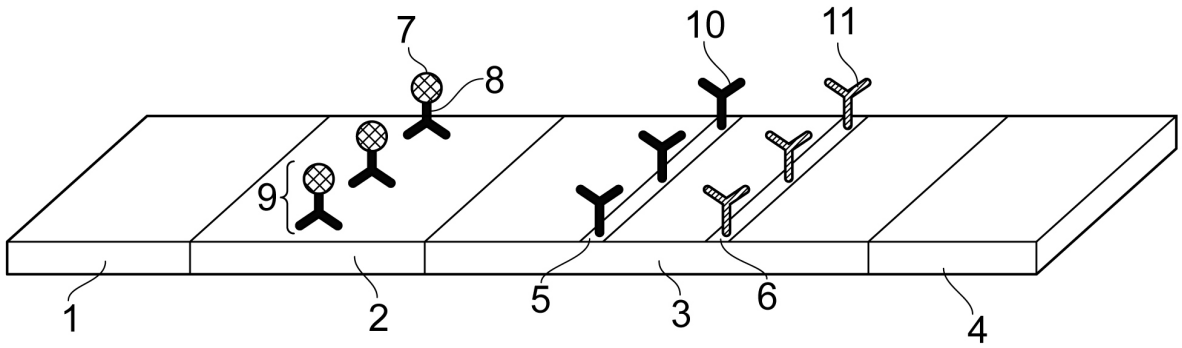

FIG. A

Product website: GoldiLocks™ gold nanoparticles

[001] GoldiLocks™ is recognised as both an innovator and a quality supplier of gold nanoparticle products. Our gold nanoparticles have been developed using specialised techniques that enable the production of extremely uniform spherical particles with a narrow size-distribution range. We are proud to offer a broad portfolio of gold nanoparticles for high-technology applications. Our spherical gold nanoparticles are available in sizes ranging from 5 nm to 400 nm in diameter, and our most popular product sizes are shown in the table below.

Product name	BabyBear™ gold nanoparticles	MummyBear™ gold nanoparticles	DaddyBear™ gold nanoparticles
Size (diameter, nm)	20	40	100
Sphericity (%)	99+	99+	99+
Odd shapes per 100 particles	<1	<1	<1

[002] Colloidal gold (a suspension of gold nanoparticles in a solvent) has been used by artists for centuries because of the nanoparticles' interactions with visible light. Gold nanoparticles absorb and scatter light resulting in colours ranging from vibrant reds (spherical particles that have a diameter of 100 nm or less) to blues to black and finally to clear and colourless. These colours occur because of localised surface plasmon resonance (LSPR), a phenomenon in which electrons on the surface of the nanoparticle oscillate in resonance with light.

[003] GoldiLocks™ gold nanoparticles are well suited for use in a wide variety of contexts, such as in solar cells, liquid crystals, catalysis and electronics. Our nanoparticles can also be conjugated to various types of biological molecules, for example peptides, proteins (including antigens and antibodies), DNA and RNA.