Gold nanoparticles improve sensitivity and specificity of genetic analysis and diagnosis

June 27 2005

Even though they don't shine, they're still worth their weight in gold: nanoscopic particles made of gold are used for a number of technical and scientific purposes. Now these tiny golden particles are being put to use in another area. Chinese scientists have discovered that the polymerase chain reaction (PCR), the basis for modern genetic testing methods, works markedly better in the presence of gold nanoparticles.

As we all know from murder mysteries, a few flakes of skin under the victim's fingernails or saliva residue on an envelope's adhesive strip are enough to reveal the perpetrator. The tiny amount of genetic material in these samples is enough to give a genetic fingerprint that can be compared with known samples and assigned unambiguously to a single person. PCR takes all the credit for this; this tremendously efficient technique allows the complete genotype or a select region of the genome to be copied.

Within a few hours, there is enough material for a variety of biological and medical tests. PCR is indispensable not only for forensics but also in research and diagnosis, for the identification and quantification of pathogens.

Here's how PCR works: the genetic material is in the form of double strands of DNA, which are first separated into single strands. A segment of the DNA sequence to be examined is marked with a short synthetic piece of single-stranded DNA, the primer. Starting at the primer, an enzyme then gets to work copying the strand, building block by building

block. This procedure, splitting the DNA into single strands and copying it, is repeated again and again.

Each cycle doubles the amount of DNA. Errors do occur in this process, which are then passed on in the copies, compromising sensitivity and specificity. This is where Chunhai Fan, Jun Hu, Zhizhou Zhang and their team step in. Their nanogold binds substantially more tightly to single-stranded than to double-stranded DNA. This effect seems to be responsible for the fact that in the presence of gold particles, fewer errors occur in the PCR and the yield is improved. This makes it possible to use smaller DNA samples from the start.

The effect of the nanogold particles is not completely understood. It is clearly analogous to a natural error
avoidance system: in cells, the protein SSB binds to single-stranded DNA, but not to double-stranded DNA,
hindering mismatches between the strand to be copied and the natural primer.

Source: John Wiley & Sons, Inc.