Some European alchemists believed that urine contained gold and spent their lives trying to extract it. The golden hue is actually due to dissolved metabolites, such as bilirubin. There are many products of our own biology in urine that we can monitor, and these are useful in determining fundamental health, as well as making sure that urine hasn’t been diluted when drug testing.

It might seem unusual to devote an entire Technical Bulletin to urine, but it is the basis of most drug testing and urine is an unusually complex fluid. The waste products of our biochemistry, and everything we ingest is expelled as liquid, solid or gas. Since most of the substances that are consumed have some water solubility, it should be no surprise that urine contains a cocktail of compounds, which include:

- Inorganic substances: bicarbonate, chloride, phosphorus, sulphur, bromide, fluoride, iodide, potassium, calcium, magnesium, iron, copper, zinc, cobalt, selenium, lead, mercury etc.
- Nitrogenous substances: bilirubin, creatine, creatinine, guanidine, choline, carnitine, piperdine, dopamine, epinephrine, nor-epinephrine, serotonin, tryptamine, urea etc.
- Amino acids: alanine, carnosine, glycine, histidine, leucine, lysine, methionine, phenylalanine, serine, tyrosine etc.
- Protein: albumin, haptoglobin, transferrins, etc.
- Immunoglobulins: IgG, IgA, IgM etc.
- Enzymes: amylases, proteases, transferases etc.
- Sugars: arabinose, arabinatol, glucose, lactose, etc.
- Vitamins: thiamine, riboflavin, nicotinic acid, biopeterine etc.
- Hormones: gonadotropin, prolactin, oxytocin, thyroxine, catecho-lamines corticosteroids etc.
- Agglutinines, precipitins and proteglobulins such as derivatives from viral protection agents, antibodies etc.
- DHEA (dehydroepiandrosterone) steroid secreted by the adrenal glands, is present in large quantities in male urine
- Drugs: illicit, pharmaceutical products, natural medicines, usually as metabolites
- Alcohol: Some ethanol is excreted unchanged

Urine is therefore very widely used in health screening, but it is also an ideal medium for drug testing.

**HOW IS URINE FORMED?**

The renal system maintains the volume and composition of body fluid by filtering blood and selectively reabsorbing or secreting filtered solutes such as salts and waste products.

Urinary generation is largely dependent on the osmosis between cells that is determined mainly by the salt level in the body. French scientist René Quinton devoted much of his life’s work to the study of seawater and in 1906 demonstrated that the content of mineral salts and their concentrations in blood plasma was virtually identical to seawater. That balance of salts in our body reflects the study of seawater and in 1906 demonstrated that the content of mineral salts and their concentrations in blood plasma was virtually identical to seawater. That balance of salts in our body reflects the right due to the presence of the liver pushing the right kidney down.

The kidneys are on each side of the vertebral column, at about the level of the twelfth rib. The left kidney is slightly higher than the right due to the presence of the liver pushing the right kidney down.

The kidneys take their blood supply directly from the aorta via the renal arteries; blood is returned to the inferior vena cava via the renal veins. The kidneys filter about one litre of plasma a minute, but only produce about one ml of urine per minute; the rest is recycled. Urine excreted from the kidneys passes down the fibromuscular ureters and collects in the bladder. The bladder muscle (the detrusor muscle) is capable of cleverly distending to accept urine without increasing the pressure inside; this means that large volumes of urine can be collected (700-1000ml) without high-pressure damage to the renal system occurring.

When urine is passed, the urethral sphincter at the base of the bladder relaxes, the detrusor contracts, and urine is voided via the urethra. This action can be triggered when required, provided the bladder has not just been emptied, so most drug test donors will be able to produce a sample when required.

**WHAT IS SHY BLADDER SYNDROME?**

Avoidant paruresis or ‘shy bladder syndrome’ is the inability to urinate when others are present, and affects about 7% of the population at some time, particularly in adolescence. Evidence suggests it is partly hereditary. This can pose difficulties with workplace drug testing where observed urine samples are insisted upon, though it is unlikely to affect unobserved collection. Testing regimes should recognise and cater for the condition, and there is growing recognition of the condition by the UK’s mandatory drug testing procedures. In the UK, employees have a general right not to be unfairly dismissed if they cannot produce an observed sample, and so have an arguable defence if this arises, but this is not the case in every country. Measures that avoid adulteration of sample, discussed in Issue 4, should largely alleviate the risks posed by unobserved collection.

**PARTITIONING OF DRUGS IN URINE**

Earlier Bulletins have discussed drug metabolism and partitioning into oral fluid, urine and hair. Most drugs excrete in urine according to their partition coefficient in urine based on pH and volume, according to ADME (Absorption, Distribution, Metabolism and Excretion).

During first-stage kidney function, any lipid-soluble drugs will stay in the plasma. But most drugs are metabolised from
virtually colourless urine. Bilirubin became a familiar name with a pharmaceutical scientist for drug metabolites in the urine.

**COLLECTING SAMPLES**

Successful drug testing starts with correct urine sampling technique, and the choice of cup is more important than you would think. Simply handing the donor a standard disposable drinking cup is unprofessional and could be risky for several reasons. There is no proof that the cup is free of drugs - whoever filled the machine could have traces of drugs on their fingers, resulting in a true positive sample from a non-drug user. At the very least, it is not unknown for keen gardeners to collect discarded drinks cups out of the bin to take them home for transplanting young seedlings (well fertilised, but not very hygienic). And at worst, the discarded cup could get reused at the water dispenser by someone. So you should be using a dedicated urine collection cup. You also need to use a temperature strip to be sure the urine is actually from the donor, and not from a bottle hidden about the donor's person. Cups designed for hot drinks are ribbed to allow narrow channels of air between the hot surface and our fingers, but this gap means that they are unsuitable for collecting urine samples because you can't read the temperature of the sample correctly. Our temperature strips are calibrated to read correctly through the thickness of our collection cups, so you can be sure of an accurate reading.

We've made collection even easier with the Integrated Cup. After opening the lid, the cup is handed to the donor and they produce a sample straight into the cup. The aperture is generous, meaning that it is ideal for both 'gents' and 'ladies' to use. Snapping the lid closed ensures the sample is securely sealed. When you're ready to conduct the test, use the key, stored in the lid, to push the plunger across. As the plunger moves across it releases a predetermined quantity of urine into the test well, and at the end of its travel seals the test well from the main chamber of the cup. With the cup now activated, the sample is taken into the integrated multipanel test, and should be read at 5 minutes by removing the label that covers the results window. All Integrated cups feature a temperature strip, and we now offer several drug combinations with built-in adulteration tests too (See Bulletin 4 for adulteration descriptions).

**SPECIAL PRECAUTIONS FOR MEDICAL TESTS**

All urine samples are suitable for drug tests but when the test includes bacteriological screening, the donor must be told to use a special procedure for collection to avoid urine getting contaminated by bacteria.

Males should wash their hands then pull back the foreskin (if uncircumcised), and wipe the head of the penis upwards with a disposable wipe, then start to urinate into the toilet before catching ‘midstream’ urine in the cup. Avoid touching the inside of the cup or the lid with hands or the penis. Women should wash their hands, and then sit back on the toilet as far as possible and spread their labia apart with one hand, keeping the folds separated for the rest of the procedure. Clean the area round the urethra from front to back, using a new wipe for each stroke. Start to urinate into the toilet before catching ‘midstream’ urine in the cup. Avoid touching the inside of the cup or the lid.

Urine that goes on to be used for bacterial analysis should have a small quantity decanted out of the cup into another for testing. Do not dip drug tests or pipettes into the original sample as these products are not sterile.

**PHYSICAL FEATURES OF URINE**

Urine is coloured by urochrome (from the breakdown of haemoglobin) and urobilin (from the metabolism of bilirubin, which also colours bile). The intensity of the colour is largely due to the water dilution factor, so anyone drinking copious amounts of water to fool a drug test will produce very pale or sometimes virtually colourless urine. Bilirubin became a familiar name with non-medical people when the character Hannibal Lecter used ‘Billy Rubin’ as a clue to the serial killer Buffalo Bill’s identity whilst taunting Agent Starling in the novel, The Silence of the Lambs. This was presumably too subtle for film fans, and its complexities didn’t reach the big screen. Lecter even jumbled bilirubin’s formula of carbon, hydrogen and nitrogen to spell out a clue to his next victim, the governor Dr. Chilton whose blond hair was a similar hue to human bile. Director Jonathan Demme would know all about bilirubin because he studied biology whilst training in veterinary medicine.

**URINE COLOURATION**

Some food dyes may be excreted in the urine, and a wide variety of drugs can discolour the urine, so colour alone is not a precise indicator of dilution.

- Cloudy, murky, or turbid (muddy) urine is characteristic of a urinary infection especially if it has an offensive smell. Murky urine may also be caused by the presence of bacteria, mucous, blood cells, epithelial cells, fat, or phosphates. Dark brown or very clear urine suggests a liver disorder such as acute hepatitis or cirrhosis. Remember though, that addicts, and those living rough may have very limited consumption of liquids.
- Pink, red, or smoky brown urine can be a side effect of a medication, or may be caused by the recent consumption of beetroot, blackberries, or certain food colours. It is also characteristic of a urinary tract disorder in which bleeding occurs such as cystitis, enlarged prostate, kidney stones, hyperemphroma or porphyria. Dark yellow or orange urine can be caused by recent use of laxatives, or consumption of B complex vitamins or carotene. Orange urine is often caused by pyridium (used in the treatment of urinary tract infections), rifampin, and warfarin.
- Green or blue urine is due to the effect of artificial colour in food or drugs, such as Rohypnol. It may also result from medications including amitryptiline, indomethacin, and doxorubicin.
- Creatinine is a waste product of protein metabolism and is not a drug metabolite, but is often included in drug testing because it can be excreted in the urine in quantities that correspond to the quantity of protein consumed. It is an indicator of renal function and can be used to adjust the results of drug testing to account for the amount of protein excreted in the urine.
excreted in urine at a fairly constant rate, so SAMHSA have ruled that if it is diluted (<20 m/dL), or abnormally dilute (5 mg/dL or less), these are critical values for identifying dilute or substituted urine. Creatinine, and not colour alone, is the best indicator of dilution, and the value can easily be checked with a SureScreen urine adulteration test strip.

Urine adulterants have been covered in Bulletin 4, but common adulterants include: alcohol, ammonia, vinegar, bleach, salt and various products purchased on the internet. The Adulteration Strip (Product 6, right) will detect all of these.

WHICH TEST IS MOST SUITABLE FOR MY NEEDS?

Virtually all applications of drug testing includes the initial rapid test on site, so once you have decided which drugs to test for, you need to choose a drug test device that meets your needs. The choice is a little bewildering, but each type has been specially designed for particular applications and budgets.

STRIP TESTS

Strips represent the simplest, and lowest-cost means of screening, and involve dipping each individual strip into the urine for around 20 seconds. These are ideal for single drug tests or where your budget is tight and available for more than 20 drug types. 
Lowest cost test.

CASSETTE TESTS

Cassettes are designed for use in a more controlled environment, where you have a flat surface and a sample cup or vial of urine to test. Run the test when you are ready by transferring three drops of urine to the cassette’s ‘sample well’, and allow the test to run. These tests are ideal for clinics, or for general screening. 
Low cost, perfect for bench testing.

MULTI-LINE CASSETTE

These cassettes test for multiple drugs using the clever multi-line format. They’re ideal if you prefer using a cassette. They are especially good for clinics, or where you have a lot of people to screen at once, because they are quicker than using drug panels, and each one can be marked up with donor details. 
Perfect for simultaneously testing up to 12 drugs.

MULTIPANELS

These are our most popular tests and they are great for multiple drug screening because they are quick and convenient. You just remove the cap, dip into urine, replace the cap and allow the result to develop. If you find yourself with a small quantity of urine, the sample can be pipetted into the cap, and the test left standing upright. The Multipanel is the popular choice for any multiple-drug screening applications. 
Many combinations available, and very easy to use. These tests have become the industry standard. 2 - 12 drugs.

INTEGRATED CUP

The integrated cup combines all of the things you would look for in a collection cup with a multipanel drug test—in either traditional or multiline format, depending on the quantity of drugs tested for. You can run the test any time after the sample has been collected, and reveal the results window after the donor has left by peeling off the obscuring sticker on the back of the cup.
Easiest test product available for collect and read system.

URINE HANDLING AND INFECTION RISK

Fresh urine from an uninfected patient is sterile, indeed urine was used in antiquity to cleanse wounds. The risk of catching any infection such as herpes from urine appears to be extremely slight, but simple medical laboratory practice should always be adopted if you will be handling someone else’s urine. A minimum requirement is to use gloves, but we would also advise covering the work area with protective paper, and wiping the area down with disinfectant afterwards. Household bleach diluted 1:9 is suitable for this purpose. Avoid any situations where the urine could become airborne, such as vigorous flushing of the sink when disposing of the sample.

WHAT TO DO WITH POSITIVE SAMPLES

The reason for screening is to eliminate negative samples in the most efficient manner, so hopefully it’ll only be the occasional positive result that needs further analysis.

The law says you must not take an illicit drug, but you should appreciate that a positive result during screening only tells you that a drug type is present, not exactly which drug in that group is present, or the actual concentration. In some cases, you could be detecting medication, and therefore its important not to jump to conclusions. Your screening procedure will probably require any positive samples to be confirmed by laboratory testing to tell you the specific drug and how much of it was in the sample.

In some circumstances you may be able to rely on rapid testing as a legally sound test if the donor admits use of the drug and signs the consent form. This approach may be valid in drug rehab centres, for example. Our consent form has a section that allows you to accept admissions from the donor.

If you do have a positive result when drug screening, there is a certain procedure to follow to make sure that the sample is treated correctly, and that all the paperwork is in order. You’ll need a Confirmation Kit, which anyone who conducts drug screening should have a few tucked away for this eventuality. The kit contains urine bottles, paperwork and evidence bags to ensure that the urine sample arrives with the lab in the same condition it left you.

PREPARING TO SEND

- Decant the sample into the two bottles provided with the confirmation kit.
- Seal each bottle with a serial numbered tamper evident seal and record the respective numbers on the consent or laboratory submission form. 
- Should the donor request one of the samples for independent analysis, they may keep one of the two sealed bottles. A record of this should be made on the consent/laboratory submission form.
- Otherwise, place both bottles in the evidence bag and record the details of the evidence bag on the consent/laboratory submission form.
- Detach the numbered receipt from the evidence bag, and hand to the donor for their personal record.
- Make two photocopies of the consent or laboratory submission form.
- Retain the original form.
- One copy should accompany the samples to the laboratory. The remaining form can be given to the donor.
- Send the samples by registered mail or another recognised postal system to the laboratory.
- At all times the integrity of the sample must be maintained. The bag and bottles are both tamper evident, meaning that you cannot open them without the seals showing signs of disturbance.

URINE STORAGE

If you cannot test a urine sample straight away, it can be kept in a sealed collection cup at room temperature for 8 hours, or for 48 hours in a refrigerator (2-8°C). For long term storage freeze at -20°C (these temperatures are what domestic fridge/freezer units
should be set to). If frozen, thaw fully to room temperature and shake or stir before testing.

**SENDING URINE IN THE POST OR BY COURIER**

Samples sent for laboratory confirmation must maintain a chain of evidence to eliminate any chance of being tampered with. The sample should go in an evidence bag that meets UN3373 spec:

- A primary leak-proof receptacle (a cup or a sample bottle) able to withstand an internal pressure of 0.95 bar - especially important if shipped by air (Royal Mail may use internal flights for Scotland to East Midlands deliveries)
- An absorbent pad suitable for soaking up spillage (a large wad of tissue or toilet roll is ideal)
- A secondary leak-proof package (the evidence bag; ours are leak proof when sealed properly, and preferably bubble-wrap protected)
- An outer package (jiffy bag, or box; minimum dimension 100mm)
- Packed in such a way that it cannot break, be punctured, or leak
- Able to pass a drop test onto concrete from 1.2 metres
- Parcels should have a diamond shape in a contrasting colour with UN3373 inside, clearly written on the outer face
- Parcels sent by Royal Mail MUST HAVE the sender’s name, address and telephone number on the outer packaging and MUST BE SENT by First Class post. Courier deliveries should also have this information on the outer packaging.

**DISPOSING OF URINE AFTER TESTING**

Positive samples should be sent for laboratory confirmation as soon as is practicable. If your procedure requires you to keep specimens, they should be frozen at –20°C as soon as possible, with indelible identification details. Negative urine and the cup contents can be disposed of in a toilet, then the cup can be put into domestic waste, or in a clinical waste bag if one is available. Medical laboratory practice permits urine to be flushed down a sink followed by a water rinse and sink disinfection.

**CONCLUSION**

Urine is our body’s way of expelling excess liquid, and the vehicle for clearing a wide variety of different by-products removed from the bloodstream by the kidneys. This makes urine the perfect candidate to test when we are looking to identify what has been happening in the body. These by-products enable us to determine the state of health and historic drug use among other things.

When screening, we are considering the what, when, why and how of drug abuse. Oral fluid, urine and hair allow us to look different windows of recent history, from impairment to months back. Inexpensive urine tests allow us to eliminate the positives in the most efficient way and will detect use in the last week. Despite the sensitive collection procedure, urine screening is still the mainstay of drugs of abuse screening.

**USEFUL WEBSITES**

SureScreen - [www.surescreen.com](http://www.surescreen.com)

Other useful sites

UK Government Statistics - [www.gov.uk](http://www.gov.uk), and search drug abuse

Drug Abuse related news - [http://www.dsdaily.org.uk](http://www.dsdaily.org.uk)

Allergies Explained - [www.allergiesexplained.com](http://www.allergiesexplained.com)

SAMHSA - [www.samhsa.gov](http://www.samhsa.gov)

SureScreen Diagnostics is one of Europe’s leaders in in-vitro diagnostic testing, including drug tests, pregnancy, disease and lifestyle tests.

SureScreen is a family-owned business with a passion to keep the British innovative spirit alive with the latest diagnostic developments.

Indeed, SureScreen is very often first in the market place with the latest tests. Choose SureScreen’s extensive range of products for best quality, competitive price and fast delivery. Every product comes from SureScreen’s dedicated team of experts with the aim of exceeding your highest expectations.