Rapid blood typing in the field

Testing for a blood group has now become simple indeed, says **S Ananthanarayanan**

BLOOD transfusion became a useful life-saver only after 1901, when blood groups were discovered. Till then, transfusion sometimes helped patients recover from blood loss or survive surgery, but it often led to their dying because of the transfusion, rather than the loss of blood. This changed when the vital factor of the correct blood group was discovered. But the process of testing blood for the correct group is still a laboratory affair and takes some time, which can compromise a patient's chances.

Mohidus Samad Khan, George Thouas, Wei Shen, Gordon Whyte and Gil Garnier, at Monash University, Australia, report in the journal of the *American Chemical Society* their innovation of testing for blood group with a strip of special paper — which can be quick and easily done by a lay person.

Blood groups

Austrian Karl Landsteiner was working with the discovery that "proteins", the building blocks of living things, "are characteristic of each species". In fact, he noted, different organs contain special proteins and it appeared that different parts of an animal of even the same species needed particular materials for their construction. This was so much unlike man-made machines, which were the rage in the 1900s, where different parts could be made from the same material!

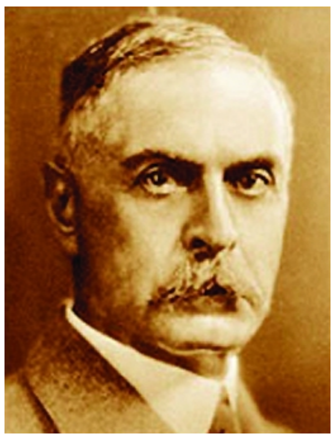
To test out whether this differentiation extended to individuals of the same species, Landsteiner tried mixing samples of blood serum and red blood cells of different persons with each other. In many cases, he noticed it was as if the blood of a person had been mixed with their own blood. But in some cases, the blood formed clusters, or lumps, an effect called agglutination, as if the blood being mixed were of different species!

With different combinations and clever detective work, Landsteiner showed that there were four blood groups — A, B, AB and O — in human blood which could be combined or could not, according to this scheme (see chart).

Thus, persons with blood groups A or B could receive blood of the same group or of group O. Persons with AB could receive any kind of blood. But persons with O could receive only O. But then, O group blood could be received by any group! AB was then the universal recipient while O was the universal donor. With the wrong blood group, the transfused blood formed "clusters" that affected circulation or the functioning of other organs and usually led to the patient's death.

Proteins at work

We now know that human blood cells have specific surface proteins that mark them as A, B, AB or O. These proteins are antigens, or agents that cause specific immune reactions when injected into another body. The blood serum, at the same time, contains antibodies, or agents that cause a reaction against specific antigens in foreign bodies.



Karl Landsteiner

Thus, A and B group blood cells have A and B antigens respectively, but the serum of each group has antibodies that act against the other group — ie, group A has B antibodies and group B has A antibodies. And group AB has both the antigens but no antibodies. And group O has no antigens but both antibodies.

The result is what we have seen — that A and B can receive blood of their own type, which has the right antigens, or of group O, which has no antigens. Group AB, which has no antibodies, can receive any kind of blood. And group O, which has both antibodies, can receive blood only of its own kind. But as it has no antigens, it can be received by any group.

For this work, Landsteiner received the Nobel Prize for Medicine in 1930.

Testing for blood group

While knowing the blood group thus makes a certainty out of the value of blood transfusion, there remains the need to test the donor and the recipient for the blood group. The usual method is to take a blood sample and mix it with reagents, one that contains the antibodies for the antigens of group A, and the other that contains the antibodies for the antigens of group B. If the sample clumps, or aggregates, with either, the blood group is identified as A or B. If it clumps with both, it is O; if with neither, it is AB.

In practice, blood is first typed by this comparison with typed reagents. Next, in a process called reverse typing, the sample is mixed with blood of a known type. Again, clumping will determine the blood type and confirm the results of the first test and make sure.

These tests are carried out in a laboratory by trained technicians with facilities that are normally available in hospitals. But this may not be true of emergencies or accident sites, and in such cases, delays in making sure of the blood type can be dangerous.

Dipstick testing

The innovation reported in the journal *Analytical Chemistry* consists of testing blood simply by depositing a drop of blood on a specially prepared piece of blotting paper.

As we know, a drop of water, or ink, or any liquid deposited on blotting paper rapidly spreads out. Similarly, if a strip of blotting paper is dipped in a liquid, the liquid rises, in the same way that the oil in a lamp rises in the wick, to burn steadily. Now, it is also a fact that different substances dissolved in the liquid rise along with the liquid at different rates. This means that if the liquid contains different substances, the substances would get separated, as the faster ones spread out, while the slower ones stay back. This property, in fact, is actively used to identify the substances in a liquid or to separate components of a liquid.

In the case of blood, too, the serum, which is mainly water, as well as the blood products, which are in suspension, spread out if deposited on blotting paper. But if the blotting paper is first treated with antibodies for different blood groups, then the red blood corpuscles of those blood groups would clump and they would not spread.

This property, of some components not spreading, can be linked to a change in the colour of the paper strip to act as a fast, inexpensive and permanently recorded test of the blood group. "The paper diagnostics manufacturing cost is a few pennies per test and can promote health in developing countries," the authors of the *Analytical Chemistry* report say.

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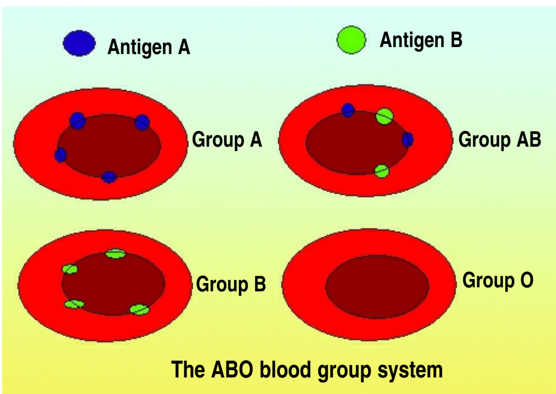
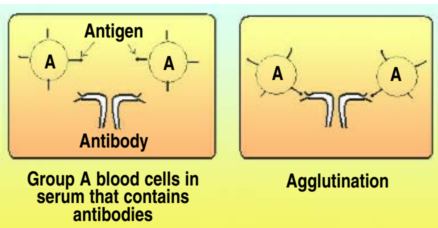
	Group	RECIPIENTS A	B	AB	O
DONORS	A	Match	Clash	Match	Clash
	B	Clash	Match	Match	Clash
	AB	Clash	Clash	Match	Clash
	O	Match	Match	Match	Match



The ABO blood group system



Group A blood cells in serum that contains antibodies

Agglutination

Means to an end

The many patterns of plant reproduction, says **Tapan Kumar Maitra**, suggest that hybridisation appears to favour apomixis

APOMIXIS is of two principal types — vegetative reproduction and agamospermy. The former is an apomictic process when it is the only means of reproduction and when the normal processes of meiosis and fertilisation are missing or nonfunctional. The strawberry, for example, is not an apomict because it reproduces by means of runners; meiosis, fertilisation and seed formation are still normal. The common pond weed, Elodea canadenis, is a facultative apomict; in northern climates it reproduces asexually and vegetatively, in warmer climates by the usual formation of seed through sexual means. The environment, therefore, appears to determine its mode of reproduction. Whether meiosis in Elodea is temperature-dependent, however, is not clearly known.

Other vegetative apomicts have their flowering parts replaced by structures called propagules, which drop off and produce plants directly. Many species of grasses and *Allium* (onion) display this mode of reproduction. *Lilium tigrinum*, the common tiger lily, exhibits both apomictic and amphimictic reproduction. Seed production is normal, but propagules formed in the axils of leaves provide an additional source of reproduction.

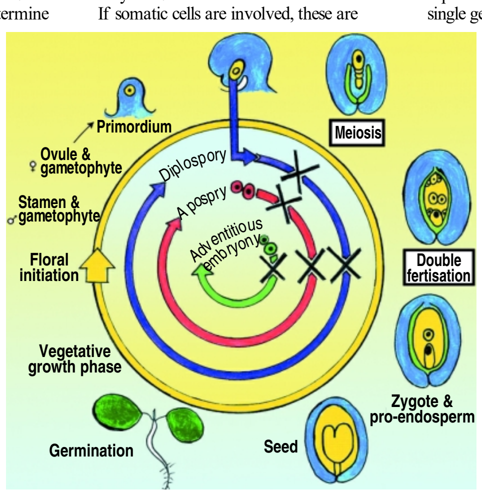
Seed production in apomicts occurs by a variety of devices and is collectively referred to as agamospermy. In one type, adventitious embryony, the embryo arises directly from some cell in the diploid sporophytic tissue of the ovule. This is commonly found in many citrus species. Maternal inheritance is, therefore, assured — an asset to the horticulturalist in maintaining and propagating a favourable variety.

Most apomictic species have retained a semblance of the sporophyte-gametophyte-sporophyte alternation of generations, but with meiosis and fertilisation eliminated as functional steps in the process of embryo formation. Referred to as gametophytic apomixes — because of a gametophyte being formed — the process utilises either somatic or archesporial cells, the latter being those that, under normal circumstances, undergo meiosis and a reduction division to form a haploid embryo sac.

If somatic cells are involved, these are usually of nucellar or integumental origin and a diploid embryo sac is formed directly by a series of cell divisions. If the cells are of archesporial origin, the meiotic processes are missing or abortive, as a result of which a gametophyte of diploid character is preserved. The nature of the stimulus-inducing development is unknown.

The great majority of apomicts are of hybrid origin and most are polyploid as well. Hybrid origin is indicated by the fact that meiosis, when present, is greatly disturbed, being usually precocious or retarded in its timing and often accompanied by failure of synapsis and normal contraction of chromosomes. As Stebbins has pointed out, they offer a wealth of material for exploitation with modern techniques and particularly for an exploration of the differences between meiosis and mitosis.

Neither hybridisation nor polyploidy cause apomixis directly, but apparently favour its appearance in some manner. Where breeding experiments have been possible, a genetic basis for apomixis is indicated. In *Allium carinatum*, a predominantly apomictic species, the replacement of flowers by bulbils is due to a single gene.



Sketch showing the initiation and progression of apomictic mechanisms relative to events in the sexual life cycle of angiosperms.

Studies carried out on guayule (*Parthenium argentatum*) illustrate this point more fully. Most of the polyploid forms of guayule are apomictic and the diploid individuals are sexual; occasional polyploids are also sexual. Breeding experiments indicate that three pairs of genes determine the behaviour of individual plants. Gene a in the homozygous condition leads to the formation of unreduced eggs; gene b prevents fertilisation; and gene c causes eggs to develop without fertilisation. Plants with the genetic constitution aa-BBCC form unreduced eggs, but these cannot develop apomictically. Fertilisation is necessary and when it occurs a higher degree of polyploidy results.

Plants with the genotype AAbbCC produce reduced eggs, but embryos are not formed because fertilisation is prevented. Those with an AABBcc genotype exhibit normal sexual behavior; cc has no effect in the presence of A and B because the eggs are reduced and fertilisation takes place. Only those plants with an aabbcc genetic constitution are apomictic. In a population of mixed genotypes, therefore, segregation would occur and fully sexual plants could give rise to apomictic offspring. Polyploidy, in increasing degrees, would serve to reinforce the genetic basis determining apomixis.

Hybridisation appears to favour apomixis indirectly in two ways. In the first place, it is the most appropriate method for bringing together diverse genomes that, by chance, have the proper combination of factors to promote apomixis. This must be a chance formation because crosses of species closely related to other apomictic forms do not necessarily yield hybrids that are apomictic, thus leaving little doubt that hybridisation is only a means to an end, rather than a direct cause of apomixis. Also the heterotic effects often found in hybrids allow for a greater expansion in the range of ecological habits found in the parent species and apomixis would tend to preserve such adapted genotypes through maternal inheritance.

From an evolutionary point of view, apomixis presents a complex and difficult problem because hybridisation, polyploidy and apomixes tend to confuse clear-cut differences between species. This is particularly true because many apomicts exhibit occasional, but successful, sexual reproduction. Each variant, therefore, possesses the potentiality for preservation and further proliferation, leading to what has been termed agamic complexes.

The structure and origin of an agamic complex can be visualised by considering the species of Crepis in western North America. Seven diploid sexual species with a base number of 11 chromosomes ($2n = 22$), have given rise to a polyploid, apomictic series having 2n numbers of 33, 44 and 55 up to 88. of morphology and ecological preference, but possess no new characters to distinguish it sharply from the diploid progenitors. Some apomicts show combinations of characters that suggest that more than two diploids must be involved in their formation. Some plants produce occasional offspring through sexual reproduction, thus contributing further to the segregation and recombination of characters.

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Gladiatorial relics

Eighty skeletons found in the suburbs of York promise to shed new light on life in Roman Britain, writes **David Keys**

ARCHAEOLOGISTS investigating an ancient Roman burial site in Britain have identified what may be the world's best preserved remains of gladiators and other arena fighters who entertained audiences through bloody confrontations with wild animals.

Eighty skeletons have been unearthed at the site in Driffield Terrace, southwest of the centre of York, over the past decade. One man appears to have been killed by a large carnivore – almost certainly a lion, tiger or bear. Others have weapon impact damage and many of them have specific features, including marks on their bones, consistent with tough training regimes.

"Our lead theory is that many of these skeletons are those of Roman gladiators and others who died in the arena. So far, a number of pieces of evidence point towards that interpretation or are consistent with it," said Kurt Hunter-Mann of the York Archaeological Trust, who is leading the investigation. The discovery is of international importance and promises to shed new light on life in Roman Britain. One important piece of evidence is the unusually high number of men with their right arms markedly longer than their left – a feature mentioned in ancient Roman literature in connection with gladiators.

About a quarter of the 80 skeletons excavated at the York site display this characteristic, and around half of

Kurt Hunter-Mann with one of the skeletons and Dr Wysocki (right)showing how a tiger tooth fits into a bite mark on a bone found in York

those have particularly significant asymmetry, with right arms between one and 1.8 cm longer than their left, according to a detailed survey of the material carried out by forensic anthropologists at the University of Central Lancashire. The discovery suggests that some men started their training at an early age, probably in their early to mid-teens. Arm length asymmetry can only develop prior to reaching skeletal maturity.

Slave owners often sold troublesome slaves to gladiatorial training schools and some gladiators did start their careers as teenagers. Almost all the skeletons are of males who were extremely robust and mostly above average height – all facts consistent with a gladiatorial interpretation – and most also show evidence of considerable muscle stress.

The anthropologists were able to identify the specific muscles involved – mainly those implicated in shoulder and arm movement – by examining tell-tale attachment marks on the bones. Similar stress evidence is present in 85 per cent of the skeletons – despite the fact that the men died at different times over a 250-year period. Current evidence from scientific tests and cranial data analysis indicates that the men came from many different parts of the Roman Empire, probably including central and eastern Europe and North Africa. "We don't have any other potential gladiator cemeteries with this level of preservation anywhere else in the world," said Dr Michael Wysocki, a senior lecturer in forensic anthropology and archaeology at the University of Central Lancashire, who examined the York skeletons. "The material is particularly significant because it includes such a broad spectrum of injuries associated with interpersonal violence."

One of the most puzzling aspects of the cemetery is that most of the men were decapitated. Although some may have sustained injuries in the period immediately before death, in most cases decapitation appears to have been the act which killed them. It is known that defeated gladiators were often "executed" in the arena by their opponents – but scholars have always thought that it was done by a sword stab to the throat. The York decapitations are from the back of the neck, suggesting that a wider range of arena *coups de grâce* were employed.

Several of the York skulls had holes that may have been caused by terminal hammer blows – a feature also seen in the fragmentary remains at a Roman cemetery in Ephesus, Turkey, where it was interpreted as a sign that the dead were gladiators. The skeletons discovered at York date from the late first-fourth century AD and all the men were buried with some respect, 14 interred together with grave goods to accompany them to the next world.

The most impressive was that of a tall man aged between 18 and 23, buried (probably in a coffin) in a large oval grave at some time in the third century. Interred with him are the remains of substantial joints of meat from at least four horses (represented by 424 horse bones) possibly eaten at his funeral, as well as some cow and pig remains. He had been decapitated by several sword blows to the neck.

Investigations into the skeletal remains are continuing. Although the archaeologists' main theory is that the men were gladiators or other arena fighters, it is conceivable that the cemetery may have been for people with *infamia* (socially disgraced) status – which would include criminals as well as gladiators and beast-fighters.

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