

Current Science Reports

Screening COVID-19 *Best antibody tests*

Antibodies, proteins produced by our immune system, detect antigens, substances that induce immune responses in the body. Antibody tests screen antibodies in your blood, produced in response to an infection. Such tests are widely used to screen for COVID-19 infections as they are easy to perform, cheap and can establish a previous infection.

However, they can give false negatives as well as false positive results. Moreover, the accuracy of different antibody testing kits has not been compared.

Now, a team of doctors from the Christian Medical College, Vellore came out with a comparative study of presently available antibody tests in India.

They took nasal samples of patients admitted to a tertiary care hospital. Patients tested as COVID-19 positive by RT-PCR were included in the study. Patients testing negative for COVID-19 were considered controls.

The team then used commercially available kits for antibody tests. Two of the kits used the enzyme-linked immunosorbent assay, ELISA, and three had chemiluminescent immunoassays, CLIA, as their basis. Some tests targeted IgM antibodies, the first type of antibodies produced in response to infections, and others targeted IgG antibodies that are produced later. One kit targeted total antibodies.

Which of these kits are more reliable, accurate?

The team assessed the performance of the different test kits in terms of sensitivity, specificity and accuracy. One ELISA kit targeting IgM antibodies had quite a few false positives. These cases turned out to be patients of scrub typhus. The kit that tested for total antibodies also gave false positives for patients with scrub typhus, dengue, malaria and typhoid

'ELISA targeting IgG, two weeks after the onset of symptoms, has the best accuracy for detecting COVID-19,' says Dr Mahesh Moorthy, Christian Medical College, Vellore.

'Time after the infection is an important determinant of the immunoassay's performance. While IgM can be detected in three to five days, the production of IgG takes longer,' says Dr George M. Varghese, Christian Medical College, Vellore.

RT-PCR is, perhaps, better for testing when infected, but the antibody tests can estimate the exposure of the population to the virus. They are also useful in cases where there are false negatives in RT-PCR tests.

Health care professionals and epidemiologists can now use this information to use the more reliable antibody test kits.

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SARS-CoV-2 Antibodies *Among pregnant women*

Pregnant women are at a higher risk of getting the infection than the general population because of their unique immune status. And previous studies showed that COVID-19 infection might cause stillbirth, intrauterine growth restriction and preterm birth.

So Kandala Aparna Sharma and team from AIIMS, Delhi evaluated the seroprevalence of IgG and IgM antibodies for SARS-Cov-2 in pregnant women.

During the second wave of the pandemic, the researchers recruited around 300 pregnant women in the 11th to 13th week of pregnancy.

Only asymptomatic women, not diagnosed with COVID-19 in the previous three months, were recruited for the study. Using a questionnaire, the researchers first collected baseline data about the women.

They also checked for COVID-19-related symptoms. Around 10% of the participants had a fever and a few had symptoms like cough and fatigue. But they did not test positive for COVID-19.

The researchers then collected the participants' serum to evaluate the titers of antibodies against SARS-CoV-2. Out of 298 women, only 220 pregnant women were willing to give serum samples for antibody checking.

The researchers used rapid immunoassays to detect IgM and IgG antibodies

in the serum samples. More than 70% of the pregnant women had IgG antibodies against SARS-CoV-2 and almost 17% had IgM antibodies. Nearly 17% of the women had both antibodies.

The results provide great reassurance that most pregnant women are at lower risk for developing the extreme pathology of COVID-19.

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Dengue Virus Vaccine *Epitope-based peptide*

Currently available vaccines are not effective against all serotypes of the dengue virus. To manage the virus, we need a vaccine covering all serotypes.

Siddharth Gupta and Ajay Kumar from Rama University, Kanpur thought of a strategy to design such a vaccine.

The first step is to identify the potential target – the antigenic epitopes or parts of the protein envelope of the virus that elicit an immune response.

Serotype 2 of the virus is the predominant variant in India. The researchers downloaded the envelope protein structure of serotype 2 from the protein database of the National Centre for Biotechnology Information.

They used bioinformatic tools to identify envelope protein epitopes that can be detected by cytotoxic T lymphocytes, cells of the immune system that detect the antigen and kill the infected cells. Thus, they identified three potent epitopes with high antigenicity scores.

The vaccines developed should not create any allergic reactions. To check whether these potential antigens in the envelope protein are safe to be targeted by vaccines, the team used the Vaxign version 2.0 beta server, a bioinformatic tool. The protein epitopes did not have any similarity to human proteins, so they could be used as vaccine targets.

To double check, the researchers used Allergen FP, another bioinformatics tool, to predict allergenicity. The envelope protein did not produce an allergic reaction in humans.

The researchers used the protein-protein docking method to examine the stability of vaccine targets by looking at their binding energies.

For the vaccines to be effective in the long term, the epitopes should not change or evolve. So the team checked whether the sequences of the epitopes that were identified were also conserved in all variants of the virus. Thus, they identified two of the three epitopes as the best targets for vaccine development.

'These two epitopes are found in all four serotypes of the dengue virus,' says Siddharth Gupta, Rama University, Kanpur.

'The next step is to perform *in-vitro* immunological experiments to validate the predicted epitopes,' adds Ajay Kumar, his colleague.

In-silico experiments can save time and money, but *in-vitro* and *in-vivo* studies are required to develop a safe and effective vaccine.

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Drought-tolerant Clusterbean Deciphering genetic basis



Image: Thamizhparithi Mari

Clusterbean is a relatively drought-tolerant leguminous crop. So, it can be grown even in semi-arid regions.

Understanding the molecular mechanism behind the drought-tolerance can help us breed drought-tolerant crops through genetic engineering.

So, researchers from the CSIR-National Botanical Research Institute, Lucknow and Kumaun University, Nainital examined the genetic basis of drought tolerance in clusterbean.

They grew drought-tolerant and drought-sensitive varieties of clusterbean in pots.

From four weeks onwards, they induced drought-stress by giving the plants lower quantities of water on alternate days. Control plants were watered to the total water holding capacity of the pots daily.

After two months, the researchers extracted total RNA from the leaves of the water stressed as well as from the control plants.

Then they prepared complementary DNA libraries containing the expressed genes of the two varieties and sequenced each complementary DNA library.

A differential gene expression analysis of the gene sequences revealed an upregulation of genes responsible for starch and sucrose metabolism in the drought-tolerant variety.

The team also conducted physiological and biochemical analyses of the leaf samples and found that relative water content was maintained in drought-tolerant plants but was reduced in the drought-sensitive variety.

'Leaf pigment concentrations and enzymatic antioxidant activities were higher in the drought tolerant clusterbean,' says Vivek Pandey, CSIR-NBRI, Lucknow.

'The drought-responsive genes identified will help improve drought-tolerance in clusterbean,' adds Mohd Akram Ansari, Kumaun University.

Deciphering the genetic basis of stress tolerance in plants is useful to produce climate-resilient crops through genetic engineering.

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Leaf Curl in Scarlet Sage? Begomovirus genome sequencing

During a survey in Gorakhpur town, researchers from the Deen Dayal Upadhyaya Gorakhpur University found stunted scarlet sage plants with curled and yellowish leaves. Scarlet sage, *Salvia splendens*, is an important ornamental plant and also a source of medicine to manage diabetes.



Image: J M Garg

When the researchers examined the curled leaves of the scarlet sage plants,

they found a striking similarity to leaf curling in tomatoes, caused by the tomato leaf curl virus. The virus is known to infect chilli and cotton too. Was the same virus infecting scarlet sage?

The researchers checked whether the disease is transmissible from diseased to healthy scarlet sage plants. To find out, they used *Bemisia tabaci* whitefly vectors, which transmit the tomato leaf curl virus. Their suspicion was confirmed to a certain extent. They decided to double check, using genetic analysis.

The team took samples of the leaves to the lab and extracted DNA. But they got a very small quantity of the purified genetic material.

'Since the quantity of DNA was too little to identify the virus, we did rolling circle amplification,' says Aarshi Srivastava, Deen Dayal Upadhyaya Gorakhpur University.

The researchers compared the sequences to other known sequences using BLAST search in the GenBank database. They found a near identical similarity with that of the begomovirus infecting cherry tomato.

'There was also very high similarity of the betasatellite of the virus infecting the scarlet sage with the sequence of the betasatellite of the chilli leaf curl virus,' says Vineeta Pandey.

The team analysed the demographic structure and observed that the haplotypes of the scarlet sage isolate were unique compared to those of the chilli curl virus genome.

'The begomovirus seems to be rapidly evolving through mutations and expanding its host range,' says Rajarshi Gaur, Deen Dayal Upadhyaya Gorakhpur University.

Genes for resistance to the leaf curl virus need to be identified to reduce the chances of the virus spreading to more crops.

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Sugar Crop Forecast Machine learning method

Sugarcane production in India has increased tremendously and India is now the largest producer in the world. To organise procurement and distribution and to make plans for export-import, an accurate crop production forecast is useful. Present yield estimates are still

based on the traditional methods: manual scouting and anecdotal estimates.

Sugarcane fields can now be easily identified by satellite-based remote sensing. But, to predict sugarcane crop yield at a regional scale from satellite images, we need to apply machine learning based on historical yield data.

So, Ashmitha Nihar, N. R. Patel and Abhishek Danodia from the Indian Institute of Remote Sensing, Dehradun recently tested various machine learning methods for predicting sugarcane yield.

They took MODIS satellite data of Uttar Pradesh, a major sugarcane producing state for the period 2000–2019.

The researchers also collected yield data from Uttar Pradesh's sugar industry and cane development department. Thus they created a dataset of over 1300 observations.

They used the land-use and land cover map from the thematic services of the Bhuvan portal of ISRO to extract the state's agricultural mask.

The team selected four machine learning algorithms to check the efficacy for predicting the crop yield.

Support vector machines can deal with high-dimensional data and limited training sets. Standard random forest is famous for its fast and easy implementation. Gradient boosting regression is an ensemble learner that builds the model from individual weak learners iteratively. The eXtreme-gradient boosting regression avoids overfitting.

The researchers decided to split the data: 80% for training and 20% for testing. They processed the data and used the same datasets to train all four models.

The northern districts of Uttar Pradesh were predicted to be the highest yielding by all four models.

The researchers found that eXtreme gradient boosting regression works faster and is more efficient. But normal gradient boosting regression gave higher accuracy.

Now, the agricultural department can try this method for regional-scale sugar crop forecasting.

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Oil Spill Remediation

Tragacanth gum hydrogel

Oil spills produced by petroleum industries pollute water bodies. To deal with

the spills, adsorption is a popular method as it is cheap and easy to use.

Polysaccharide gums are good adsorbents. Tragacanth is one such gum extracted from *Astragalus*, a genus of leguminous plants. The gum absorbs water and becomes hydrogel.

Can we use the gum to remove oil spills from water bodies, wondered researchers from the CT Institute of Pharmaceutical Sciences, Punjab.

Acrylic acid and methyl methacrylate are known for their affinity for oil. The team set about grafting these to the tragacanth gum. They used ammonium persulphate and glutaraldehyde as cross-linkers for linking acrylic acid and methyl methacrylate to tragacanth gum.

Using X-Ray diffraction, they found that grafting and crosslinking improved the crystallinity of gum tragacanth.

'Increased crystallinity made the polymer thermally more stable,' says Saruchi, CT Institute of Pharmaceutical Sciences.

The researchers used the cross-linked and grafted hydrogel to adsorb crude-oil from water. And they optimised different physicochemical parameters to get the maximum oil adsorption using the hydrogel.

The adsorption of the crude oil increased as the amount of adsorbent was increased.

The maximum oil adsorption occurred at an adsorbent dosage of 3 grams at 40 degree Celsius when oil was 0.03 gram per litre of water.

'The gum tragacanth hydrogel grafted with methyl methacrylate can be used to remediate oil spills,' says Vineet Kumar, CT Institute of Pharmaceutical Sciences.

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Detecting Microplastics

With microwaves

Plastic pollution is omnipresent, yet detecting minute unwanted plastic particles is a hassle. The commonly employed techniques such as visual identification, spectroscopy, and spectrometry are cumbersome.

To address these issues, researchers from IIT Bombay and MUT, South Africa came up with a technique to detect microplastics.

They analysed four commonly detected polymer types – low density poly-

ethylene, high density polyethylene, polypropylene and cross-linked polyethylene.

Most commonly used plastics are dielectric in nature: they do not conduct electricity but are polarised when an electric field is applied.

Based on these properties, the researchers devised a method to detect polymers using microwaves.

The team analysed the samples in a cavity resonator, a hollow piece of equipment where the sample is bombarded with microwave radiation – non-ionising long waves of the electromagnetic spectrum.

The researchers measured resonant frequency and the corresponding quality factor for the empty cavity as well for the one with the samples.

When the microwave frequency matches the cavity resonator's frequency, the cavity absorbs energy which is then analysed by a vector network analyser. The network analyser observes the change in frequencies in the cavity resonator. The data is then displayed on an interface computer.

When a dielectric substance is introduced in the cavity holder, the permittivity changes slightly and the material gets polarised. The researchers used this property to detect the polymers.

They found that microwaves of S-band frequency, between 2 and 4 gigahertz, when passed through the samples, are good at detecting the polymers.

'This method is non-destructive and requires only a small quantity of sample,' says Renjith VishnuRadhan, IIT Bombay.

'This technique can be used to detect plastic particles in environmental and biological samples,' adds T. I. Eldho, IIT Bombay.

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Carbon from Carbohydrates

For supercapacitor electrodes

Super capacitors have excellent charge storage capacity and faster charging-discharging rate than conventional batteries. In enhancing charge storage, the physical and chemical properties of the carbon electrodes play a vital role. But the preparation of carbon material requires high temperature or the addition of impurities.

Recently, researchers from IIP Dehradun and IISER Pune tried preparing carbon materials from naturally abundant carbohydrate molecules.

They selected six types of carbohydrates – three monosaccharides, arabinose, xylose and galactose, and three disaccharides, lactose, cellobiose and maltose. These molecules differ from each other by the hydroxyl groups, the size of the ring structure, substitutions, and the types of glycosidic linkage which join the carbohydrate units.

The researchers synthesised carbon from the carbohydrates by heating them under a continuous flow of nitrogen.

Then, they prepared electrodes from these materials and compared their physical and electrochemical properties.

'The type of glycosidic linkage in the chemical structure of the carbohydrates has a significant impact on charge storage properties' says Shivam Rawat, IIP, Dehradun.

Disaccharide-derived carbon showed higher capacitance than monosaccharide-derived carbon. Among the six candidates, maltose-derived carbon and cellobiose-derived carbon showed good charge storage capacity.

'The maltose-derived carbon electrode shows highest specific capacitance because of high surface area, narrow pores and alpha glycosidic linkage,' says Thallada Bhaskar, IIP, Dehradun.

'Such insights into different linkages and the polysaccharides involved will

help in the development of excellent supercapacitors,' adds Srinivas Hotha, IISER Pune.

Being renewable and abundant in nature, carbohydrates can be a choice for supercapacitor manufacturers.

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Sociality In Rats

Subicular lesion

Two male Wistar rats, when caged together with adequate food and water, soon get to know each other well. When the door of the cage is opened, the one that is more adventurous gets out quickly, leaving behind the meeker one.

A team of researchers at NIMHANS, Bengaluru kept the meeker rat trapped such that the door of the cage could only be opened from the outside and allowed the other rat to explore a wider arena. The rat roaming freely outside would help the caged rat by opening the door and squeal with delight at 50 kilohertz and exhibit playful behaviour with the released mate.

However, if instead of the mate, a cotton ball was kept in the trapped cage, the rats tended to ignore it and did not open the door from outside.

The researchers were investigating the role of the ventral subiculum, a structure next to the hippocampus in the brain, in social behaviour. They introduced a lesion in the ventral subiculum of a set of rats by injecting ibotenic acid, a neurotoxin.

Their earlier experiments had shown that such rats display more anxiety and that, if they are kept in a condition exposed to 6 hours of light and 18 hours of darkness, their anxious behaviour is reduced. So the experimental rats and controls were subjected to a 12 hour darkness and 12 hour light condition.

Rats with lesioned ventral subiculum, the researchers found, tend to ignore their caged mates. They do not open the door or exhibit playful behaviour or emit the high frequency ultrasonic sound. Instead, they emit more 20 kilohertz frequency sounds, emitted by normal rats when they encounter aversive situations.

The researchers say that they plan to study the precise role of the subiculum in social cognition and pro-social behaviour. They suspect that the subiculum may be involved in autism and related social disorders.

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