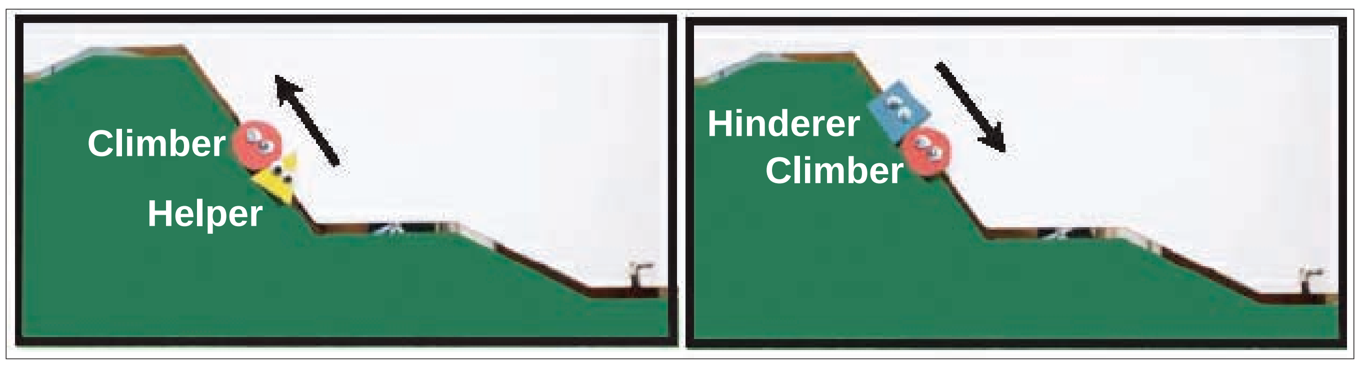
Genetic bases of moral sense

Infants are found to have a sense of fair play that may be inborn, says s ananthanarayanan



Dr Jessica Sommerville.

CHARLES Darwin, in his 1871 book *The Descent of Man and Selection in Relation to Sex,* identified "the moral sense or conscience" as by far the most important difference between humans and animals. Genetic bases have been found for "pack loyalty" and the "wired-in" altruism of social insects like ants, but the question is open of how early in live humans relate to fairness and cooperation. Dr Jessica Sommerville, assistant professor at the Institute for Learning and Brain Science, University of Washington, recently published findings of toddlers as young as 15 months, making out the difference between fairness and favour.

Basic to research concerning pre-verbal infants is the observed behaviour of infants who pay more attention to the things that surprise them — the "violation of expectations" paradigm. Using the same tool, Sommerville and others recorded the attention of babies to footage of people being given bowls of crackers and milk — the babies consistently showed surprise when the shares were unequal. And a further finding was that infants who were most sensitive to the equality of shares were also the most likely to share a favourite toy — a finding that *fairness was not only expected, it was also preferred*.

Research in a related area that was published in the journal *Nature* in 2007, by Hamlin, Wynn and Bloom of Yale University was about the ability of infants to recognise helpful behaviour or make out "friend from foe". Social organisation and interaction is squarely built on this ability and human adults rapidly assess others, based both on behaviour as well as physical features. The work showed that six- and 10-month old infants considered a person's action towards others in evaluating the person as appealing or aversive — they preferred the helper to the hinderer, the helper to the neutral person and the neutral person to the hinderer.

In an experiment, the toddlers were shown a character, a wooden figure with large eyes, trying to climb up a hill. In the third attempt, the character was either "helped" by a second figure, a "helper", with a push from behind or was pushed down by a third figure, a "hinderer" (see diagram). The infants were repeatedly shown helping and hindering instances, and their "looking time" measured till, after some trials, the time settled down, indicating that they had processed the sequence. Now, when shown instances of the "climber" approaching the "helper" or the "hinderer", the infants consistently "looked" longer at the climber approaching the "hinderer" as surprising behaviour, against approaching the "helper", which was expected.

The next question to answer was, what would the infants' own attitude be towards the "helper" and "hinderer" — did observing how the individuals behaved with a third party affect the observers' evaluation of that individual? This test was simply done by allowing the infants to "reach for" either the helper or the hinderer – they showed a strong preference for the helper; they had formed distinct impressions about the characters based on the behaviour of the characters towards others.

While this experiment had the same results with nine-month and tear-old babies, in the case of six-month babies, the infants still preferred to reach for the "helper" for themselves but did not register longer "looking" time when the "climber" approached the "hinderer". This indicates that the six-month-olds had formed social evaluation, for their own choice, but were still unable to transfer the learning to infer the choice to be made by another.

Yet another experiment was done to eliminate the possibility that the babies were only showing a preference for "up" over "down", rather than evaluating a social interaction. In this experiment, the climber figure was first made "inanimate" by removal of the eyes and displaying no motion of actions of its own. The "helper" and "hinderer" then either smoothly pushed the "climber" "up" or "down" the hill. The effects on the pushed objects were the same as before, except that now the social interaction had been removed. Now, when the infants were tested for choice, it was found that there was no preference — the figures were only "pushers up" or "pushers down", not "helpers" or "hinderers", which existed in a social context.

In yet another experiment, the infants were exposed to the same first trial, with either a "helper" or a "hinderer" and also a fourth "neutral" figure who neither helped nor hindered. When asked to make a choice, again the infants went for the "helper" over the neutral figure and the neutral figure over the "hinderer". They were hence both drawn towards the "helpers" as well as independently inclined to avoid the "hinderers". In "looking time" trials, however, neither six- nor 10-month-olds were able to evaluate the choice of the "climber" for the "helper/hinderer" — a finding that though this could be done when the "helper/hinderer" were performing opposing actions, 10-month-olds could not work out how a third individual would respond when the actions were less distinct.

Research had already established that within six months toddlers learn to show preference based on static features, like facial or racial indicators. By the time they are 18 months, they engage in spontaneous cooperative helping behaviour. But the display, at just six months of age, of a preference for such behaviour in others strongly suggests that this is biological adaptation. Humans are more complex than wolf packs or ant colonies and cooperative behaviour needs to be honed by identification and reward — individuals need to make out the helpers or cooperators from the freeloaders and there has to be a "selection" to keep the numbers healthy.

Social evaluation may also be the basis for the development of a sense of moral judgment and the concepts of "right or wrong". The research reported brings out the capacity of very young infants to function judgmentally with characters never before encountered and in a situation where they themselves had no stake. The evaluations were based on how they saw what happened between unknown individuals. More research would reveal refinements like, do infants prefer agents who punish the "hinderers" over those who are "indifferent" or who act as "hindrance rewarders", etc.

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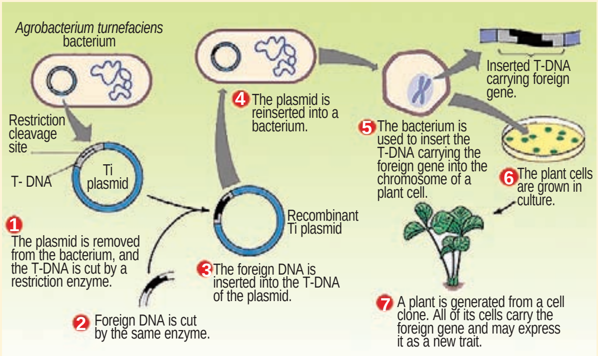
Higher yields

tapan kumar maitra **on how genetic modification can improve the traits of food crops**

THE ability to insert new genes into plants using *Ti plasmid* has allowed scientists to create Genetically Modified crops with a variety of new traits. For example, plants can be made more resistant to insect damage by introducing a gene cloned from the soil bacterium *Bacillus thuringiensis* (*Bt*). This gene codes for a protein that is toxic to certain insects — especially caterpillars and beetles that cause damage by chewing on plant leaves. Putting the *Bt* gene into plants such as cotton and corn has permitted farmers to limit their use of more hazardous pesticides, leading to improved yields and a significant return of wildlife to crop fields.

When a million cotton farmers in China switched to growing an insect-resistant strain of GM cotton, they reported a 20 per cent increase in yields. They used 78,000 tons less pesticide and there was a significant drop in deaths among farm workers from pesticide poisoning. A similar rationale has led to the introduction of genes that enable crops to resist weed-killing herbicides, thereby allowing for higher yields and the use of fewer toxic chemicals.

GM can also be used to improve the nutritional value of food. Consider rice, which is the most common food source in the world. Currently consumed by more than three billion people daily, at least half the world's population is expected to depend on rice by 2020, especially those in developing countries among whom many suffer from deficiencies in essential nutrients and vitamins. To illustrate how genetic engineering might be used to improve the situation, the genes required for the synthesis of *b-carotene*, a precursor of vitamin A, were genetically engineered into rice in 2001. It has been proposed that the resulting product, called "golden rice" because of the colour imparted by *b-carotene*, might help alleviate a global vitamin A deficiency that now causes blindness and disease in millions of children. Golden rice is currently undergoing testing and evaluation to determine whether such benefits can be achieved.



Of course, adding a single vitamin to a single crop is not enough to prevent malnutrition. But if it turns out that such techniques can be safely used to enhance the vitamin and nutrient content of staple crops such a rice, wheat and corn, it could go a long way in improving the overall nutritional status of the world's population.

Food spoilage is another area that has been tackled by genetic engineering. An interesting example involves the problems associated with storing and transporting tomatoes. To make them less susceptible to damage and give them a longer shelf life, commercially grown tomatoes are generally picked before they have fully ripened. But such tomatoes do not taste as good as those that have ripened on the vine. Scientists have tried to overcome this problem by using genetic engineering techniques to create the so-called "Flavr Savr" tomato.

Their strategy was to inhibit the production of *polygalacturonase* (*PG*), an enzyme that catalyses cell wall breakdown and thereby causes tomatoes to rot. *PG* was inhibited by inserting a copy of the *PG* gene into cells in a backward orientation, causing the affected cells to produce an abnormal mRNA that is complementary to that produced by the normal *PG* gene. The abnormal mRNA, called an *antisense mRNA*, binds to the normal mRNA by complementary base pairing and prevents it from functioning, thereby leading to decreased production of the *PG* enzyme.

Because they produce less *PG*, Flavr Savr tomatoes are less susceptible to rotting and can therefore be allowed to ripen on the vine rather than being picked green and hard. Although the resulting tomato tastes better and has a longer shelf life without spoilage, it has not been a commercial success because conventional tomato-handling equipment tends to damage soft, ripened tomatoes.

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No bones about it

A research institute in Kolkata and another in Trivandrum have developed an ideal bone graft that meets every criterion and is, more importantly, very affordable. kaushik dey **reports**

THE human skeleton is made of bone — a hard connective tissue comprised of hydroxyapatite, collagen and water. Sometimes, because of trauma or other reasons, bone is lost and requires replacement by a surgical procedure that involves grafting. Conventionally, Autograft — bone taken from the patient's body – is employed. But because of limited availability and also disadvantages like the need for a second surgical procedure, donor site pain, procurement morbidity (bone unsuitable for grafting), surgeons in developed countries have been employing Allograft — bone taken from another person (cadaver); Xenograft — bone taken from an animal (bovine); and Alloplast — synthetic bone prepared chemically.

Over the years several disadvantages have been associated with Allografts and Xenografts, some of these involving immunogenic reactions, a transfer of disease and inconsistent clinical results. In these circumstances, a lot of research has been carried out in India for the development of an ideal bone graft that can overcome these disadvantages and, instead, resemble natural bone — like osteoconductivity, osteostimulativeness, biodegradability, absence of risk of infection transfer, unlimited availability and non-immunogenicity. This research is the more worthwhile considering that imported comparables are expensive and beyond the reach of many.

In recent times, the Central Glass and Ceramic Research Institute, Kolkata, a constituent laboratory of the Council of Scientific and Industrial Research, and the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, have developed several synthetic bone grafts for use in dental, oral, maxillofacial and orthopaedic segments that are comparable to imported ones but moderately priced. These indigenously developed synthetic grafts are available under the brand name BioGraft and are being used successfully. The CGCRI, Kolkata, has been developing new generation ceramic materials for different biomedical applications and it has an ethical committee that handles the medico-legal norms set by Indian Council of Medical Research, New Delhi. Considering the multiplicity of the subject, the institute even has an extensive network between other scientific organisations working in similar fields.

Dr Debadeep Chakraborty, a leading oral and maxillofacial surgeon at Peerless Hospital and BK Roy Research Centre, said, "The bone graft, due to its ready acceptance by the body and its ability to chemically bond to the surface, will relieve your sufferings within a very short time. If your tooth is obstinate enough and has to be removed, then the surgeon will painlessly remove it and preserve the socket with the bone graft. Some intricate cavities may not agree to a direct implant of bone grafts but bioceramists have solved the problem by converting solid biografts into cements, putties and injectables that can easily access any part of the jaw, set *in situ* and relieve pain. Synthetic bone graft is a near-pervasive bioceramic material that is the ideal choice for any problem related to bone." Bone graft also finds application in strengthening the roots of weak teeth and aligning them properly through some simple surgery, he said.

Dr Nikhilesh Das, consultant orthopaedic surgeon at Peerless Hospital, Kolkata, said, "When a large section of bone has had to be removed for, say, bone cancer, the surgeon pushes bone grafts into service as a filler. Bone fillers have the desired consistency, particle size, porosity and strength, and these are available in abundance are in sterile condition. The bone filler will provide a scaffold and encourage the rapid filling of the void by naturally forming bone. It will also become part of the bone structure and will reduce healing time.

The CGCRI has developed a process for the synthesis of calcium hydroxyapatite ceramic in the form of porous granules/blocks for application as bone graft material. After in-vitro and in-vivo tests on animals, porous granules were implanted. Post-operative studies showed complete tissue integration and wounds healed within 12 weeks of surgery."

Indeed, CGCRI and SCTIMST deserve credit for developing state-of-the-art, clinically proven synthetic bone grafts and other bio-ceramic products like Synthetic Hydroxyapatite Orbital Implant and Alumina Ceramic Femoral Head.

When an eye is damaged due to injury or disease, the surgeon removes the eyeball from its orbit to avoid risk to the other eye. The lost eye is mechanically replaced by an Ocular Orbital Implant to fill up the volume lost after evisceration to achieve better cosmetic rehabilitation. However, conventional ocular implants generally made of glass, marble, acrylic and polymer do not provide for satisfactory functional and cosmetic rehabilitation and have a lot of disadvantages, including a high exclusion rate. Because of this, the patient is apt to suffer stigma or taboo – which prevails in Third World countries. The CGCRI, together with the Society for Biomedical Technology, has developed porous integrated synthetic bioactive and biocompatible orbital implants that provide satisfactory functional and cosmetic rehabilitation. Synthetic refers to the manufacture of Hydroxyapatite by a process that results in a highly porous, fully-interconnected orbital implant that is similar in structure to natural bone. Biocompatible means a prosthesis that is accepted by the human body. Similarly, bioactive means integration of the prosthesis with tissue cells to provide stability and motion. This bioactive intra-orbital implant is available in the market as CeraEye and provides a natural look. CeraEye also reduces post-enucleation socket syndrome generally associated with retraction of the upper eyelid.

Professor Jyotirmoy Datta, head of the Department of Ophthamology, Calcutta National Medical College, has been using CeraEye for several years and said, "Presently, the bioceramic research group is handling an R&D project on the development of porous hydroxyapatite ocular implants for application in the field of ophthalmology. The artificial eyeball designed and fabricated at the institute has been characterised thoroughly at first for different physical, chemical and mechanical properties in the laboratory. Comparable orbital implants were being imported at exorbitant prices and, thus, the benefits and advantages thereof were within the reach of only the upper segment of society. CeraEye, however, is moderately priced and affordable — within Rs 6,000."

Those with a cleft lip or palate are objects of sympathy, but medical science provides the cure. Surgery repairs the cleft lip/palate, followed by nasal correction and then the application of HA over the alveolus and maxilla surface. Bone formation occurs after six months. Bone graft is also used for sinus-lifting preceding placement of dental implants and for ridge expansion.

Given the popularity of fashion shows and beauty contests, men and women are increasingly conscious about their appearance, especially their faces. Here, too, biografts have helped. In India, babies born with craniofacial clefts run into the several thousands per year. Adults with facial, skeletal and soft tissue defects because of acquired factors number much more. Synthetic Hydroxyapatite Bone Graft material is a useful alternative where the donor area is limited and/or donor area morbidity is unwanted. It allows for the growth of fibrovascular tissue and osteoconductivity and can thus be used for correcting facial, skeletal and soft tissue defects. This material is biocompatible, non-allergenic, non-toxic and qualitatively superior to imported Hydroxyapatite. It is also affordable. After six to seven months the area operated upon becomes hard and there is clinical evidence of bone formation. Synthetic Bone Grafts are also useful in aesthetic dermatology, cheek augmentation, as cosmetic fillers.

These indigenous products are available through IFGL Bioceramics, Kolkata, and are manufactured as per technical knowhow of CGCRI and the Sree Chitra Tirunal Institute of Medical Sciences and Technology, Trivandrum. They conform to ISO standards and are not consumer items but are, instead, delivered to the surgeon concerned for implant.

Dr Debadeep Chakraborty.

Dr Nikhilesh Das.

Professor Jyotirmoy Datta.