



# TECHNOLOGY

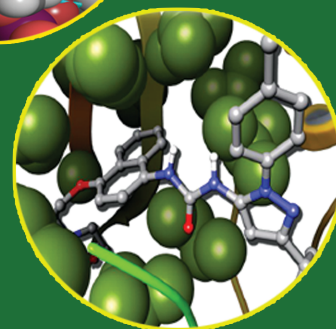
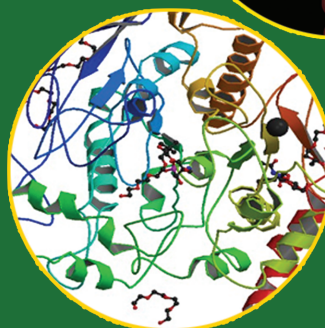
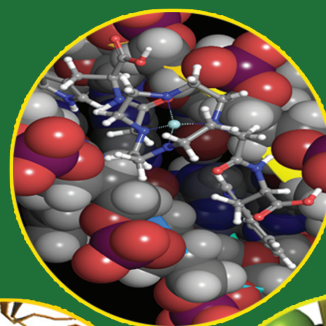
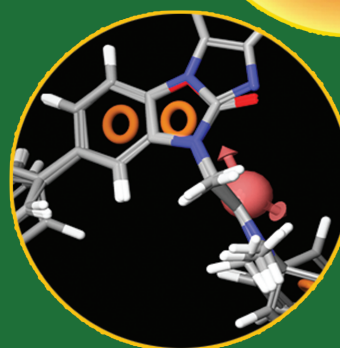
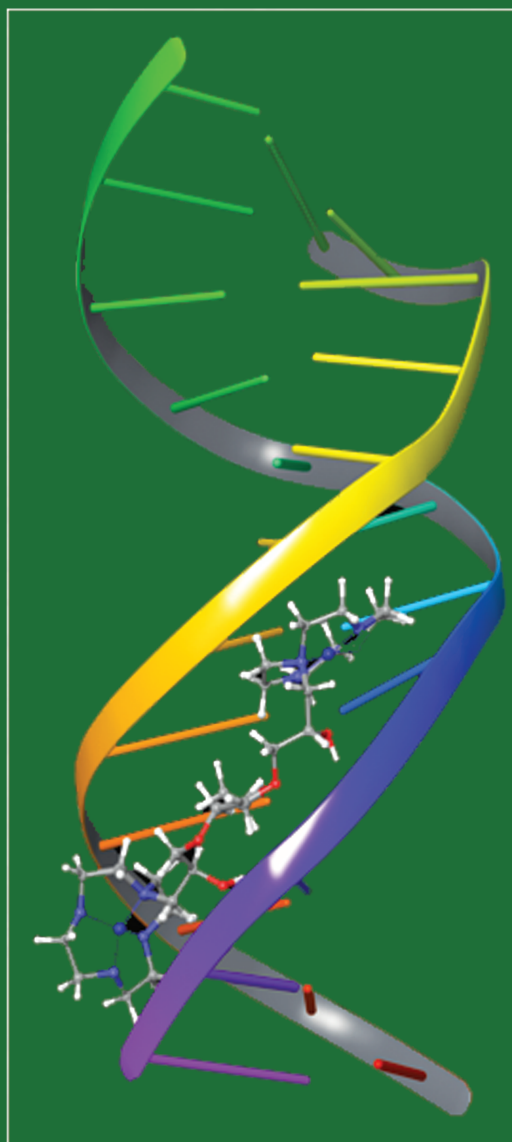
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# FOCUS

Bimonthly S&T Magazine of DRDO

Vol. 25 No. 4, July-August 2017

## Biomedical Technologies





## *From the Desk of Guest Editor*



*Institute of Nuclear Medicine and Allied Sciences (INMAS) has become an important biomedical institute which caters primarily to the armed forces and to the society at large. To enhance the efficiency of armed forces, INMAS has made significant efforts in expediting the development of herbal radioprotectors, radiolabelled diagnostic kits, diagnosis and treatment of thyroid disorders, non-invasive imaging, endocrine and bone mineral metabolism studies as well as biomedical products and drugs for combat casualty conditions and high altitude maladies.*

*The Institute has also made effective contributions in preparing the nation for the unconventional yet realistic Nuclear, Biological and Chemical (NBC) warfare scenario. Many antidotes have been developed for use in NBC related emergencies and have been given approval by Drug Controller General of India.*

*Two herbal radio protective formulations/drugs are in advanced stages of development. Besides this, INMAS has conducted a series of training programme in the field of CBRN defence for military and paramilitary forces like National Disaster Response Forces (NDRF), Indian Navy Medical officers, Armed Forces Medical Service (AFMS), Border Security Force (BSF), Indo-Tibetan Border Police (ITBP), Central Reserve Police Force (CRPF), Intelligence Bureau (IB), and Parliamentary Security Services, etc.*

*Many of the new products developed by INMAS are providing low-cost and improved medical support for high altitude conditions. LIC/NBC products such as protective clothing for medical first responders, UMBRIEL for UV radiation protection, chitosan based INMASEAL gel/gauze are extremely useful in case of battlefield conditions, new dental restorative material and lead free radiation attenuation material for dental purposes, BAP-LiCl for decreasing cellular radiation injury, PET radioligands  $^{14}\text{C}$ -MBMP for TSPO quantification, radioactive decorporating agents, anti-nerve gas agents, anti-cyanide drugs, agents against radiation damage and toxic agents, etc., are at different stages of clinical trials.*

*I am happy that Technology Focus is bringing out this special issue to highlight some of the technologies developed by INMAS to create awareness about the achievements of this Institute.*

**Dr A.K.Singh**  
Outstanding Scientist and Director

## BIOMEDICAL TECHNOLOGIES

The Institute of Nuclear Medicine & Allied Sciences (INMAS), one of the establishments under Defence Research & Development Organisation (DRDO) is working in the field of life sciences to address global challenges of combat casualty and Nuclear Biological and Chemical (NBC) emergencies through R&D. It includes development and customisation of agents/biomedical devices, training for CBRN emergencies, advancements in radiation medicine and specific molecular imaging probes for monitoring soldiers' health. Besides this, the Institute is also engaged in solving other health related problems of Indian defence forces who serve at high altitude and extreme environmental conditions/combat situations in terrains which are very inhospitable.

Presently, the major focus is on radiation and medical countermeasures to enhance Institute's

capabilities and to contribute effectively in the nation's preparedness for unconventional warfare scenario.

During last year, several innovative initiatives have progressed successfully and number of products/drugs and formulations have reached to advanced stage of development. The necessary clearances have been obtained for new drug formulations used for CBRN emergencies. Two radioprotective drugs are in advance phase of development. Radiation biodosimetry laboratory has been accredited by Atomic Energy Regulatory Board (AERB) Mumbai through IAEA. Innovations and research in molecular imaging and radiopharmaceuticals research is now proving to be of tremendous value to the armed forces and society for early diagnosis of number of diseased conditions.

### AERB Accreditation for Assessment of Personnel Radiation Exposures

INMAS is the third laboratory in India and the first in MoD to have accreditation from AERB. Ionising radiation like gamma rays causes damage to DNA resulting in the formation of dicentric chromosomes which is highly specific to radiation. The dicentric chromosome formation increases proportionately with radiation. The identification of dicentric chromosomes requires highly trained personnel.

The laboratory envisions to prepare a network of biodosimetry laboratories at different geographical locations of India and in command Hospitals, so that in case of nuclear radiation exposure emergency, all the laboratories could work in a coordinated manner to provide service to exposed personnel.







## Chitosan-based Haemostatic/Wound Healing Hydrogel-(INMASEAL Gel)

Chitosan hydrogel (5 %) is meant for haemostasis and wound healing. It comprises Chitosan, Acetic acid, Calcium chloride, Sodium alginate, and water.

### Salient Features

- ◆ Cost-effective
- ◆ Gel quantity to be applied as per wound depth to fill it completely
- ◆ Pressure may be required for some time to stop bleeding
- ◆ Field trials carried out by paramilitary with satisfactory results and positive feedback

### Indications

- ◆ Big/deep wounds and lacerations after cleaning to stop bleeding onsite
- ◆ Part of regular dressing of acute burns and wounds for faster healing
- ◆ For reducing oozing in chronic ulcers/burns/diabetic foot, etc., as regular therapy

### Applications

- ◆ Field blast/gunshot injury
- ◆ Road traffic accidents
- ◆ Accidental falls

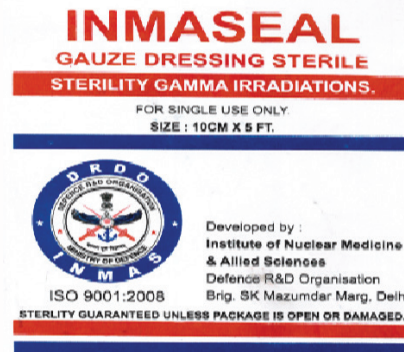


## Cotton Gauze Impregnated with Haemostatic/Wound Healing Hydrogel-INMASEAL Gauze Dressing

Chitosan gauze dressing (1 %) is meant for haemostasis and wound dressing. It comprises Cotton gauze, Chitosan, Acetic acid, Calcium chloride.

### Salient Features

- ◆ Sterilised by gamma irradiation
- ◆ Easy to use



INMASEAL gauze dressing

- ◆ Cost-effective
- ◆ Light-weight
- ◆ For single use only

Chitosan gauze dressing is applied directly on the wounds and has to hold physical pressure for several minutes till the bleeding stops. It can be stored at ambient room temperature in dry place. Direct exposure to heat and sunlight has to be prevented. Its shelf life is two years from the date of manufacturing.

**Presentation:** 10 cm x 5 ft gauze size

**Capabilities:** The product is Chitosan impregnated cotton gauze wound sealant that reduces bleeding and stops oozing of blood. The medicated cotton gauze can be used in any environment from high altitude to hot environment of Rajasthan border area. Developed product is able to stop oozing of blood in significantly short span of time with enhanced natural wound healing process.

### Applications

- ◆ Field gunshot injury
- ◆ Road traffic accidents
- ◆ Accidental falls

## Protecting Health at High Altitudes by Countering Radiation Injuries to Skin

A novel, innovative, Ultraviolet (UV) radiation protective formulation has been developed. The formulation has combination of bioactive botanicals, including a patented plant extract. It is meant for



protecting the health, by countering skin injuries and thereby rendering help in improving the efficiency of soldiers deployed at high altitude locations. The trade name UMBRIEL is registered by DRDO.

The technical know-how (ToT) of UMBRIEL was transferred through Directorate of Industry Interface & Technology Management (DI<sup>2</sup>TM), DRDO to M/s PERCOS India Pvt. Ltd (GMP and ISO certified Indian Multinational unit).



UMBRIEL is non-toxic, approved by Drug Licensing-cum-Controlling Authority, India and has passed third party evaluation. FICCI, in consultation with global domain experts, has suggested a high market potential of UMBRIEL.

The soldiers at high altitudes suffer unique injuries by specific flux and wavelength of UV radiation, which are not known at planes. The hypoxia, extreme cold, and dry winds prevalent at snow clad mountains, enhance the UV injuries by many folds. UMBRIEL is the first preparation developed to specifically counter these injuries. UMBRIEL has passed highly sensitivity tests (Infrared-thermography, biochemical and genetics); cuts-off > 97 per cent UV, counters DNA dimers; photosensitivity, and oxidative stress. Under field conditions, UMBRIEL is stable at -20 °C, which is the temperature experienced at Leh, Dras, and Siachin, etc.

## INDAPT: A Safe and Effective Adaptogen Against Combat Stress and Fatigue

Combat stress amongst the armed forces has been a debatable issue since decades. Epidemiological evidence indicate a tremendous increase in the rates of affective dysfunctions including suicides in military and paramilitary forces.

The stress of military operations can tax a soldier to his outermost limits. Negative reactions to this stress may include lack of alertness, poor decision

making, fatigue, sleep disorders, and an overall performance decline. Moreover, the misconduct behaviours, and combat stress reactions are other outcomes of the combat stress.



Therefore there is a need to develop an effective but safe adaptogens, anxiolytics, and anti-depressants against chronic stress-induced changes in performance. This study indicated the effectiveness of some natural substances against mental fatigue-induced decrease in the physical performance. A further study is required to translate the potential leads.

## Remocon Wipes

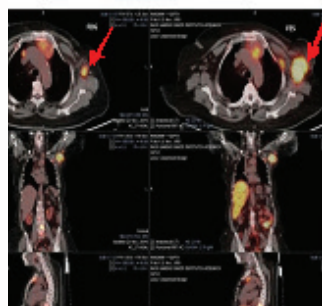
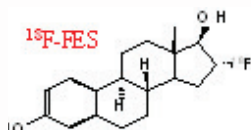
Remocon wipes made of Remocon lotion is a body wipe that can be used very effectively for removing radiologic contaminants. The formulations have a unique ability to adhere to the localised area, minimise solution run-off and to maintain required wet contact time between the detected agent and the formulation. Moreover, the wiping shall enable a complete and fast removal of contaminants from the body.



Remocon wipes

## PET Tracer, 16 $\alpha$ -[<sup>18</sup>F]-Fluoro-17 $\beta$ -estradiol-FES): Healthcare Support to Estrogen Receptor Positive Female Cancer Patients

Among females, breast cancer is now the most common form of cancer in many cities and second most in the rural areas of India. One fourth of all female cancer cases are of breast cancer. Estrogens are the major role players in the initiation and progression of the breast cancer and approximately 75 per cent of the tumors express the estrogen receptor. For the first time in India, clinical production of 16 $\alpha$ -[<sup>18</sup>F]-FES, an Estrogen Receptor (ER) specific PET tracer, has been carried out at INMAS. PET imaging with [<sup>18</sup>F]-FES has proved a useful tool not only in the diagnosis of primary cancer but a vital tool for catering the patients with history of ER-positive breast cancer in whom a clinical dilemma remained despite complete standard work-up (e.g., when imaging procedures are inconclusive and performing a biopsy is not feasible). The development of tracer highlights preparedness not only for the benefit of society but also for aspiring females in uniform in providing better healthcare services and support.



## Human Patient Simulator

Human patient simulator is an interactive mannequin that is basically meant for medical simulation. It is almost full-sized patient with life-like features such as airways, pulmonary system, cardiovascular system, pharmacologic, trauma, and patient monitoring, etc. Preparing a training module for medical management of CBRN casualties is a complex activity because the scenario involves not only mass casualties but also strange medical crisis and physical conditions, extenuation, etc. The necessity of decontaminating the victims prior to initiating specific treatment and the criticality

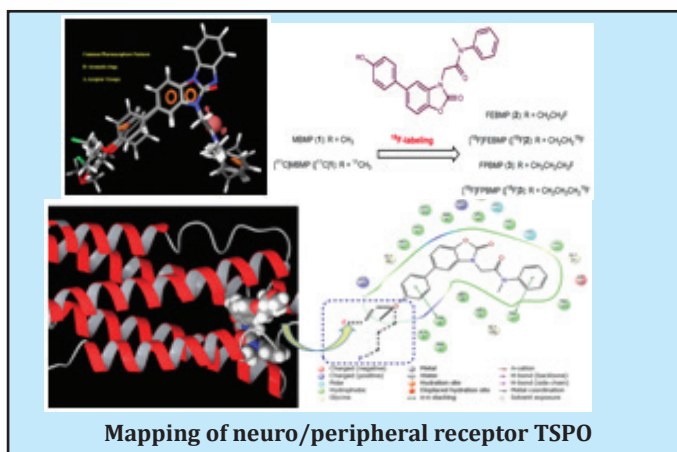


Moulage kit

involved in physically safeguarding paramedics from secondary cross-contamination has influenced the need for preparedness of the medical professionals for specialised training. The medical simulation technology training is primarily conducted on the human patient simulator with moulage kit.

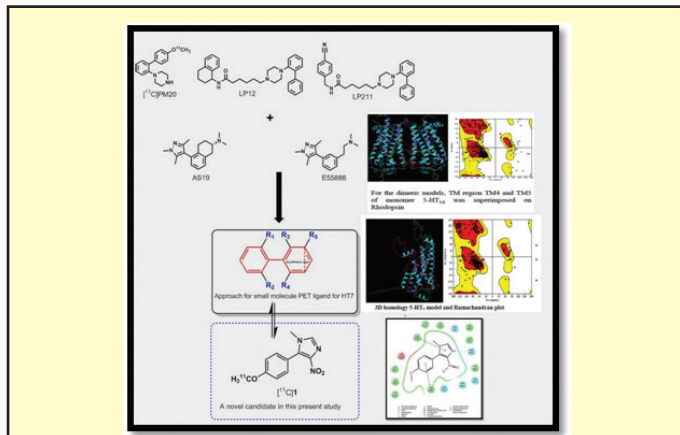
## Mapping of Neuro/Peripheral Receptors

Recently a new series of PET ligands is developed for mapping of 18 kDa Translocator Protein (TSPO) which is a target for neuroinflammatory conditions like trauma/stroke. 2-[5-(4-Methoxyphenyl)-2-oxo-1,3-enxazol-3(2H)-yl]-N-methyl-N-phenyl acetamide (MPMB) and two fluoro derivatives (FEBMP/FPBMP) were evaluated for assessment of TSPO expression in brain/peripheral organs through PET studies. These studies demonstrated that [<sup>14</sup>C] MBMP/[<sup>18</sup>F]FEBMP crosses the Blood Brain Barrier (BBB) with observable brain uptake and interacts selectively with TSPO without significant interference from metabolites. *In vitro* autoradiography on postmortem human brains showed that TSPO polymorphism did not affect these ligands which is the major drawback of current TSPO ligands.

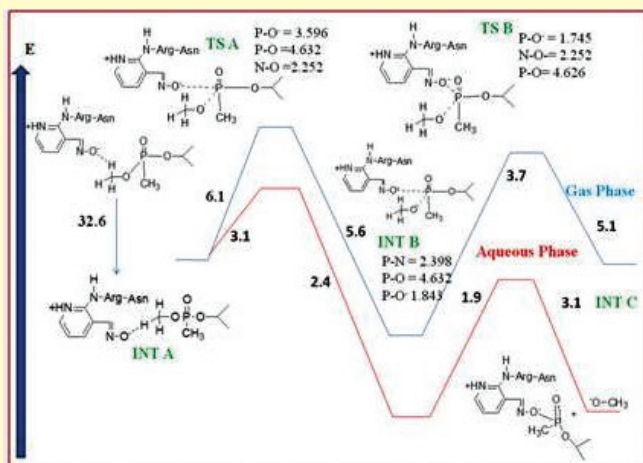
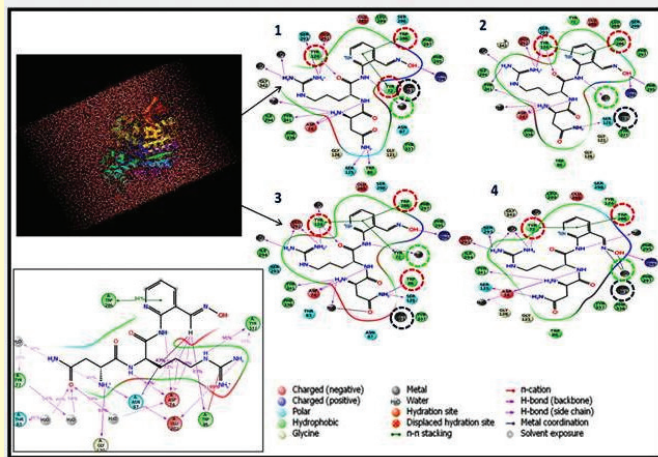


Mapping of neuro/peripheral receptor TSPO





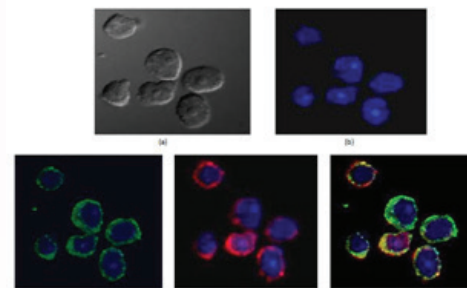
Specific ligand for HT7/HT1A receptor quantification in CNS (depression / memory)



Oxime-Dipeptides as anticholinesterase and reactivator of Phosphonylated-Serine of AChE during nerve

## Multi-layer Encapsulated Cell Population and uses their-off (Alginate-Fbn Conjugate)

A patent (2159/DEL/2015, Indian patent) is filed for the preparation and use of fibronectin/SDF-1 (protein/peptide) modified alginate for cell encapsulation. It successfully encapsulate the cells while maintaining cellular activities. The encapsulation of Hematopoietic Stem Cells (HSC) is likely to prevent their premature differentiation (through growth factors mediated stimulation) in blood stream upon transplantation while maintaining their viability. Upon reaching bone marrow, the coat of HSC would be knocked off due to high concentration of fibronectin/SDF-1 in the blood vessels supplying to bone marrow, therefore facilitating their onsite delivery. The formulation filed for patent also finds its application in decreasing the graft-vs-host disease, which occurs due to incompatibility between the host and engrafted cells and tissues.

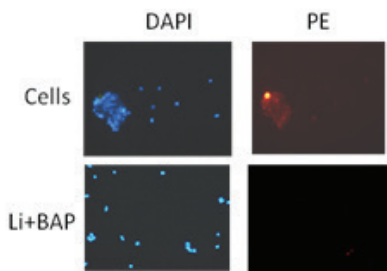


Confocal microscopic images showing K562 cell (hematopoietic in nature) coated with Alginate-Fibronectin formulation (red coloured). The coating does not alter shape and size of K562 cells. No fluorescence was observed in FITC panel (green). DIC: white light image.

## Bax Antagonist Peptides in Conjunction with LiCl for Decreasing Cellular Radiation Injury

Cell death upon radiation injury progresses through a series of events regulated mainly by the Bcl-2 family members such as Bax. The anti-apoptotic member, Bcl-2, of this family was used as a template to design and test novel BAP for its antagonism based cell death suppression. The BAP (GR23) was found to display translocation across



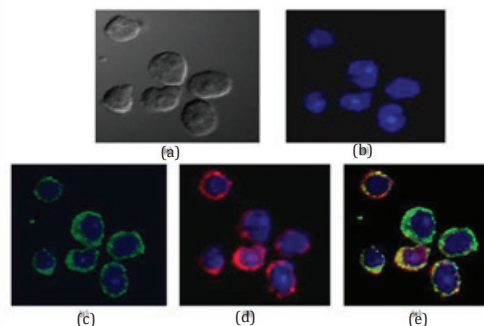


Caspase-9 p10 subunit was undetectable in irradiated cells treated with both LiCl and GR23

cell and nuclear membrane with cell surviving effect. This was synergised 2-fold when cells were pre-treated with LiCl. The combined formulation filed for patent finds its utility in radiation injury, Parkinsons, Alzheimers and radiotherapy for cell protection. (DEL/201611006832. Indian patent)

### Preparing a Multi-layer Encapsulated Cell Population and Uses Their-off (Alginate+Chitosan LbL)

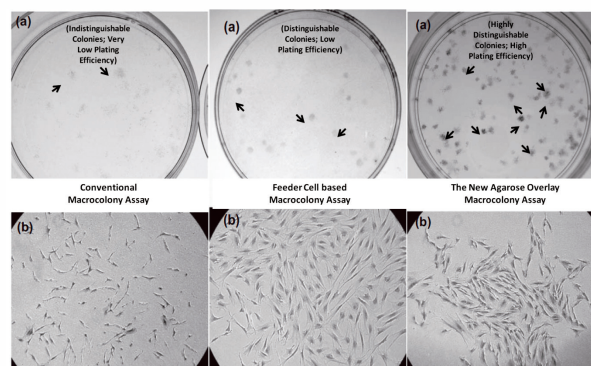
Living cell encapsulations in polymeric shells are receiving increased attention because of their wide range of possible applications in biotechnology and medicine. Encapsulation of cells using nano-organised layer is of major importance in medical applications, since they can be used as protective shells for local delivery of normal or engineered cells. A single cell encapsulation of hematopoietic progenitor cells by applying layer by layer technique (LbL) is performed which employs sequential deposition of the oppositely charged polymers over the negatively charged cell surface. In the patent, INMAS reported the use of cell shielding in preventing/reducing the severe conditions which arise after bone marrow/stem cell transplantation such as immune rejection and graft vs host reaction and how the shielding also stop the binding of cytokines, growth factors which can cause premature stimulation of transfused cells before reaching the bone marrow. Polymers Chitosan and Alginate for coating K562 cells (a hematopoietic progenitor) though LbL technique is used. Confocal microscopy was performed to confirm the nano-deposition of fluorescently labeled polymers over cells. Filed Patent Number : 2158/DEL/2015 (Indian patent)



Confocal microscope images of encapsulated cells (a) DIC (b) DAPI labeled (c) Chitosan FITC coated (d) Alginate- RBITC and (e) merge

### Agarose Overlay Technique

Radiosensitivity assessment of isolated cells or primary cell strains can be used for predicting individual susceptibility to radiation induced damage in patients and healthy subjects. The cell types generally available for such predictive assessment are peripheral blood leucocytes or lymphocytes, due to their easy availability and processing. However, these cells are one of the most radiosensitive cell types within the human body. Assessing radiosensitivity from primary skin fibroblasts could be an important alternative. The *in vitro* clonogenic mammalian cell survival or colony formation assay, which is used extensively for characterising the radiation sensitivity of monolayer cultures of mammalian cells, is difficult to perform with primary fibroblasts due to their inability to form distinct and scorable colonies. Although primary fibroblasts have been studied for survival response, these generally yield very low colony forming efficiency in the conventional colony forming assay, generating very lightly stained,



Chandna et al., International Journal of Radiation Biology, May 2014; 90(5): 401-406

### Agarose overlay technique

irregular and diffused colonies in contrast with the compact colonies formed by tumourigenic cell lines.

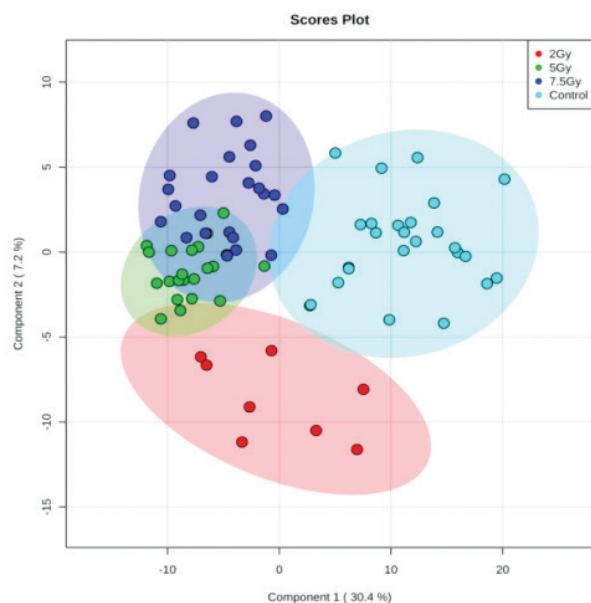
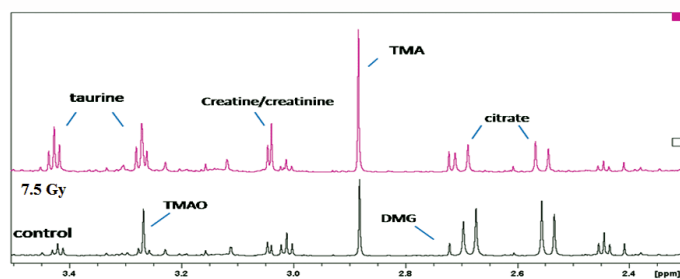
As a result of the high mobility and/or increased dependence on the presence of neighbouring cells, fibroblasts in their early passages may have higher proliferation potential but may resist focal growth and pose significant problems in clonogenicity assessment. A well known example is the VH10 human primary foreskin fibroblast cells, which have rapid cell proliferation and are quite suitable for understanding radiation and stress response of normal untransformed cells. However, these fibroblasts display very low Plating Efficiency (PE) with conventional assay, and with moderate improvement when seeded with feeder cell supplementation. Colony forming efficiency of fibroblasts may be moderately enhanced by supplementation with feeder cells, which provide them with increased amounts of growth factors and enhance their colony forming ability. The use of feeder cells can however be a limiting factor in designing large scale experiments, and is quite labour intensive. In the present study, a simple one-step agarose overlay method is introduced that caused significant enhancement in the plating efficiency of primary fibroblast cells and yielded far more distinct colony morphology, thereby considerably improving the macrocolony formation of these primary cells even as compared to the feeder cell supplementation method. This study further demonstrates that similar effect is absent in the transformed or tumourigenic cell lines, thereby establishing the selective nature of fibroblast response to agarose micro-environment.

The agarose overlay technique was able to support cell proliferation while considerably reducing the cell migration and facilitating the appearance of densely staining colonies. This method is not only simple to perform, but also saves the time and cost required for generating feeder cells. Moreover, it resulted in considerably higher plating efficiency than that achieved using the feeder cell supplementation. The primary fibroblasts overlaid with agarose showed enhanced focal growth and proliferation associated with increased surface adhesion. Cell morphology and adherence in cells overlaid with agarose compared very closely with the cells fed with feeder layer,

confirming that overlaid agarose matrix provides these cells with vital extracellular micro-environment that promotes cell adhesion and growth even in the absence of any growth factor supplementation. In fact, the plating efficiency of primary fibroblasts increased to an extent that only a small number of cells needed to be seeded for assessing Surviving Fraction (SF) even at high doses up to 5 Gy. Therefore, the radiosensitivity of these cells could be successfully evaluated. The technique thus provides a reliable, sensitive, inexpensive, and user-friendly alternative for assessing individual radiosensitivity using primary skin fibroblasts, which can be easily isolated from a human patient or donor. This technique was developed in a collaborative exercise taken up on invitation of Stockholm University's Centre for Radiation Protection Research. This method can be utilised as a clinical predictive assay before subjecting an individual to radiation treatment, or can be used to detect hypersensitive individuals within a healthy human cohort.

### **Metabolomics: A Powerful Tool for High Throughput Radiation Biodosimetry**

With the increased threat of nuclear war, accidents during the use of radioactive material in industry, research and medicine and intentional use of dirty bombs by the act of terrorism, the soldiers and civilian population are likely to get exposed to ionising radiation, which will cause serious radiation injuries and ultimately death depending upon the absorbed dose. There is a clear and inescapable need for a high throughput technique to determine the absorbed radiation dose to triage and facilitate medical management of large numbers of radiation exposed casualties. The existing methods though well established are time consuming, labor and manpower intensive and hence grossly inadequate for a triage. INMAS proposed a new emerging non-invasive NMR spectroscopy based technique named metabolomics for high throughput radiation biodosimetry. It involves the application of advanced analytical and statistical tools to profile changes in levels of endogenous metabolites in tissues and biofluids resulting from disease onset (clinical set-up) or radiation, thermal, and isolation stress or



**Radiation biodosimetry**

extreme environmental condition exposure (military scenario). Scientists from INMAS, have been able to differentiate groups of experimental animals based on changes in their metabolic profile of biofluids when exposed to different degree of radiation using NMR spectroscopy based metabolomics and chemometric analysis. Few urinary metabolite markers for radiation exposure have been identified with good sensitivity and this technique is now being used on human patients undergoing radiation therapy for their specificity. INMAS is now in the process of developing a predictive model based on these markers for high throughput screening which would segregate radiated population from non radiated ones. Similarly, metabolomics has also found its application in identification of markers associated with thermal and high altitude stress. In fact some metabolomics based preliminary studies on adaptogenic herbs such as *Tinospora cordofolia* (Tc also known as Guduchi) has shown promising findings as a prophylactic agent against cold stress.

In near future metabolomics approach will have great potential towards development of personalised healthcare and targeted pharmaceuticals, early warning indicators of disease risk, enhancing capabilities for monitoring and surveillance of disease control programs. Such knowledge is envisioned to enhance a combat service member performance and lower the risk of life-threatening injury. It would be ideal to be able to predict how a single combat service member will perform under a variety of different dietary and other environmental conditions based upon his or her phenotype.

### **Non-human Primate (NHP-Monkey) Model for Pre-clinical Studies on Radioprotection**

Rising probability of human exposure to radiation/nuclear catastrophe has necessitated the urgency to develop safe countermeasures. INMAS have been working in this field for decades. During exploration a novel combination of two compounds isolated from high altitude plant has been found promising in delivering protection to various animal models against sub-lethal and lethal radiation exposures. This combination has been able to save radiation exposed murine organ systems like gastrointestinal, hematopoietic, and pulmonary systems. The predominant pathways involved in radioprotection are pro-survival, immune, DNA repair, inflammation and oxidative stress. Cell cycle arrest at G2M phase and free radical scavenging property of both compounds have played lead role in countering deleterious effects of radiation. Safety studies conducted as per Schedule Y have indicated the safe nature of this combination. Currently, studies of formulation, as per Drugs Controller General of India guidelines are in process. Since human subjects cannot be exposed to radiation for revealing the efficacy of formulation during clinical trials, it is essential to conduct pre-clinical studies in such an animal model which is biologically closest to human (US-FDA). Considering the necessity of the study, Non-human Primate (NHP-Monkey) model has been selected for pre-clinical studies. For the first time a study on radioprotector development has progressed to such a stage where NHP will be studied.





## Feedback for Technology Focus

**We have been receiving a tremendous appreciation & good words on the contents, quality, and presentation of Technology Focus and we intend to continue with our efforts. The editorial team requests your support to further improving it. The feedback form as below would be one of the resource that would provide us your level of satisfaction and newer aspects you would want to incorporate in the Technology Focus.**

Rate the **Technology Focus** as a medium to present DRDO's technology and product developments ?

- Excellent       Good       Satisfactory       Needs improvement

Is **Technology Focus** highlighting developments of DRDO appropriately ? If no, kindly suggest ?

- Yes       No

How do you rate the quality of photographs in the **Technology Focus** ?

- Excellent       Good       Satisfactory       Needs improvement

Optimal number of pages you would like for the **Technology Focus** ?

- 16 Pages       20 Pages       24 Pages       28 Pages

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## NBC Drugs and Devices Developed

### Decorporation Agents

#### Injection EDTA

Injection EDTA (Ethylenediaminetetraacetic acid) is the conventional all-purpose decorporating agent suitable for bivalent metallic radioactive cations. In case of a radioactive scenario, most of the radioactivity in the environment will be in the form of bivalent cations, making EDTA exceptionally useful. It is one of the most important general purpose decorporation agent due to safety and efficacy. Not available as over the counter drug in Indian market or otherwise on prescription.



Injection EDTA

#### Tab Potassium Iodate 85 /170 mg

It is an oral decorporating agent specific for Radioiodine. Presently 140 mg of potassium iodide is the recommended drug which acts by reducing residency of the radioactive iodine in the body. However, the stability is very less (1-3 months only) and the dose is based on very old calculations. INMAS have replaced the old drug by gastric coated potassium iodate in less than half the conventional dose without reducing the efficacy and increasing the shelf life significantly. This drug is recommended to be used as prophylactic to I-131 internal contamination. In case of continuing fallout, some experts recommend post-exposure administration also.



Potassium iodate tablet

#### Cap/Tab Prussian Blue 500 mg and Duodenal Release 200 mg

Prussian blue is a well known radiocesium/thallium decorporating agent given in dose of 3-10 gm a day orally. The non-absorbable drug chelates Cs-137 and Tl-201 from bile and prevents it systemic re-entry. The product is a duodenal release pH dependent formulation of Prussian blue that is shown to be much more effecting, leading to reduction in dose of the rare drug. As a result of improved technology, 200 mg tab is equivalent to 1 gm conventional Prussian blue tablet. Production capability for indigenous Prussian blue has been generated for the first time in India. It is proposed to be dispensed under food grade certification. Human data suggests 70 per cent enhanced decorporation of internalised radioactivity. Post-exposure treatment of radiocesium and radio-thallium and industrial/homicidal use of non-radioactive isotopes of thallium will require this medical management. Its administration is possible without any risk as prophylactic and in suspected cases due to nil side effects.



Prussian blue tablet

### Radio Protectors

#### Injection Melatonin (20 mg)

Oral route is significantly slower than parenteral route. Typically, peak drug concentration in blood after intravenous injection occurs in 2-3 min, after intramuscular injection in 25-30 min and after oral administration in 60-120 min. Also, in case of melatonin, there is lot of first pass degradation in liver upon oral administration. Based on pharmaceutical principles, 20 mg parenteral melatonin would be





**Melatonin injection**

equivalent to 50 mg oral administration with much faster therapeutic action.

## Decontamination Solutions

### Radioactivity Decontamination Kit (Advanced)

Advanced decontamination kit contains all the reagents and items of basic kit but additionally contain EDTA-surf excel mix, cetrimide soap solution, sodium thiosulphate, EDTA eye/ear drops, EDTA mouth and hair wash, hair remover cream, scissors, safety razor, EDTA wipe, super absorptive polymer, wood pulp gauze and absorptive wound dressings. Potential users include services, DAE, disaster response agencies, nuclear medicine and radiotherapy establishments. Single kit is sufficient for 25 persons with primary and 1-2 confined secondary contaminations.

### Radioactivity Absorptive Mopper and Sprinkler

Radioactive contamination of the working surface and floor is a constant probability in nuclear establishments handling open radioactivity, installations where radioactivity spills are anticipated and during transport of radioactivity. Most of the time radioactive spills are confined by phase transition from liquid to solid that is easily removable. This is done simply by using blotting paper or technically more sophisticated absorptive polymers. Use of Super Absorptive Polymer (SAP) which can jellify spilled radioactivity within seconds, and makes handling of the solid radioactivity much easier. Absorptive capacity of SAP is easily between the range from 1:250 -1:500, a few hundred mgs of SAP is all that is required to confine milliliters of the usual spill. Basic device consists of a plastic bottle of



**Radioactive absorptive mopper and sprinkler**

50-100 gm filled with SAP powder with a sprinkling top. For a longer shelf life SAP is to be prevented from moisture. Potential users may include Services, DAE, NDRF, nuclear medicine establishments and agencies handling or transporting radioactivity.

## New Dental Restorative Material

Barodontalgia is an oral pain caused by a change in barometric pressure in an otherwise asymptomatic tooth with a faulty restoration which have been found at high altitude, military aircrafts (3000-25,000 ft) and deep sea (SCUBA) divers (30-40 ft). Its novel composition aims for zero per cent dimensional changes with respect to pressure and has omitted toxic components like mercury and bis GMA polymer have been developed on which animal studies have been completed. This is useful for army, navy, air force and also for general dental use.

## Polymer-based Lead Free Radiation Attenuation Material

Polymer-based lead free radiation attenuation material, the product almost near completion is a paradigm shift in radiation attenuation protocol. It is lead free and causes zero damage to environment. It is soft, light-weight, flexible, elastomeric and carries density 1.2 g/cc. It could be useful for all diagnostic and interventional radiology. It may carry application in CBRN warfare and space explorations.

### Products implemented/Under implementation

Drug	Use
Inj Amifostine	Radio protector
Tab indralin	Radio protector
Tab Potassium Iodate	Decorporation agent
Tab Prussian Blue	Decorporation agent
Tab Alginic Acid	Decorporation agent
Inj Ca-DTPA	Decorporation agent
Inj Zn-DTPA	Decorporation agent

### NBC Drugs Approved by DCGI

Alendronate sodium tablet, DPI and respiratory fluids	Uranium decorporation
Alpha ketoglutarate DPI and oral	Cyanide antidote
Atropine DPI, respiratory fluid and sublingual	Anti nerve gas agent
Calcium disodium EDTA DPI and RF	Decorporation of monovalent divalent tionic radionuclides

### Other Drugs Developed for Government Agencies

Inj melatonin	Radio protector
Tab melatonin-caffeine	Radio protector
Melatonin nasal drops CNS	Radio protector
Tab NAC (N Acetyl Cysteine)	Radio protector
Cap/Liq Curcumin	GI Radio protector
Tab Multi-vit-caffeine	Radio protector
Inj EDTA	Decorporation agent
Inj Zn-EDTA	Decorporation agent
Chitosan gel and scaffold	Wound care
Nalbuphine nasal drops and spray	Pain Management

### NBC Radio Protective Equipment and Devices

Medical personal radioprotective dress	Protection from radioactivity
QMRT dress (colour coded)	Protection from radioactivity
Skin decontamination kit (basic)	Radioactive decontamination
Skin-would-eyes decon kit (Advanced)	Radioactive decontamination
4 % EDTA soap	Radioactive decontamination
EDTA wipe	Radioactive decontamination
EDTA wipe (advanced)	Radioactive decontamination
HAM sprinkler	Radioactive spill management
Radioactive spill mopper	Radioactive spill management
Radioactive liquid waste collector	Radioactive bio-waste management
Radioactive blood dressing material	Medical management
Chitosan dressing	Wound care



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*Editors acknowledge the contributions of Dr Anjani Tiwari, Sc 'E' of Institute of Nuclear Medicine & Allied Sciences (INMAS) in preparing this issue.*

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डेसीडॉक द्वारा प्रकाशित

Published by DESIDOC

RNI No. 55787/93