



# GURU NANAK COLLEGE (AUTONOMOUS)

Affiliated to University of Madras and Re-Accredited at "A" Grade by NAAC

Guru Nanak Salai, Velachery, Chennai – 600042.

## Guru Nanak Centre for Research

<b>Event Title</b>	<b>NATIONAL WEBINAR ON “THE ROLE OF TRANSGENIC FISHES IN DRUG DISCOVERY AND THE SCOPE FOR ENTREPRENEURSHIP”</b>	
<b>Category</b>	UG/PG STUDENTS, RESEARCH SCHOLARS AND FACULTY, PROFESSIONALS AND INDUSTRY PERSONS	
<b>Date</b>	<b>From : 1.10.2020</b>	<b>To : 1.10.2020</b>
<b>No. of Resource Person</b>	<b>1</b>	
<b>No. of Participants</b>	1000	

### 1. Report Description:

The Guru Nanak Centre for Research (GNCR) of the Guru Nanak College (Autonomous), Velachery, Chennai organised the **NATIONAL WEBINAR ON “THE ROLE OF TRANSGENIC FISHES IN DRUG DISCOVERY AND THE SCOPE FOR ENTREPRENEURSHIP”** on 1<sup>st</sup> October 2020 from 12.00 Noon to 1.30 p.m. with the aspiration to highlight the significance of the role of transgenic fishes in Drug Development and the enormous scope and opportunities available for entrepreneurship. This National Webinar was planned and well accomplished by Dr. J. Jayanthi, Dean Research, Guru Nanak Centre for Research (GNCR) under the able direction of our Most Revered General Secretary & Correspondent, Sardar Manjit Singh Nayar and constant support from our Respected Principal, Dr. M. G. Ragunathan.

The **NATIONAL WEBINAR ON “THE ROLE OF TRANSGENIC FISHES IN DRUG DISCOVERY AND THE SCOPE FOR ENTREPRENEURSHIP”** was inaugurated by our Respected Vice Principal (Student’s Affairs) Dr. L.R.S. Kalanithi with the Welcome Address. Vice Principal Madam welcomed the Resource Person, Dignitaries of the College Management, Faculty from Guru Nanak College and the participants from across the Globe who joined virtually. The Theme of the Webinar was introduced by the Convener of the webinar, Dr. J. Jayanthi, Dean Research of Guru Nanak Centre for Research. Dr. J. Jayanthi, Dean Research mentioned that huge responses were received from more than 800 registrations and the webinar

programme was livestreamed in YouTube on our official channel “GURU NANAK CENTRE FOR RESEARCH”.

Dr. Mahendrakumar. M, Assistant Professor, Department of Biotechnology, Guru Nanak College (Autonomous), Chennai introduced the Resource Person, **Prof. S. G. PRAKASH VINCENT**, Professor & Head, Centre for Marine Science and Technology, Rajakamangalam Campus, Kanniyakumari, Manonmaniam Sundaranar University, Tamil Nadu. Dr. S. G. Prakash who is a DAAD Fellow (Germany) during his Ph.D. Dr. Prakash who is holding many positions in academic and research portfolios which includes EMBO WP Fellow (Germany), UNESCO Fellowship Awardee (Italy), Mariecurie Fellow (EMBL), Chairman Associate – BRICS Biomed Consortium and he is the FOCAL POINT, European Commission HORIZON 2020.

Dr. S.G. Prakash very clearly explained the step by step process involved in Drug Discovery and explained the various benefits and advantages of using transgenic fishes at various level of Drug Development and testing the efficiency of a lead drug molecule. He also narrated the different diseases for which drug development have been possible using transgenic fishes. Dr. S. G. Prakash also gave a vivid picture about the huge entrepreneurial opportunities available for Start Ups regarding Drug Discovery and Development. The resource person Dr. S.G. Prakash answered all the questions raised and clarified all the doubts of the participants.

Dr. J. Jayanthi, Dean Research narrated the important points of the presentation of Dr. S.G. Prakash in her concluding Report of the **NATIONAL WEBINAR ON “THE ROLE OF TRANSGENIC FISHES IN DRUG DISCOVERY AND THE SCOPE FOR ENTREPRENEURSHIP”**. The Webinar ended well with the Vote of Thanks delivered by the Organising Secretary of the Webinar, Dr. Mahendrakumar. M, Assistant Professor, Department of Biotechnology, Guru Nanak College. All the Participants were given a certificate of participation.

## 2. Invitation



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## GURU NANAK CENTRE FOR RESEARCH (GNCR)

### NATIONAL WEBINAR ON

### *"THE ROLE OF TRANSGENIC FISHES IN DRUG DISCOVERY AND THE SCOPE FOR ENTREPRENEURSHIP"*

DATE : 1<sup>st</sup> OCTOBER 2020 | TIME : 12.00 Noon - 1.00p.m.

**RESOURCE PERSON** Prof. S. G. PRAKASH VINCENT



Professor & Head,  
Centre for Marine Science and Technology,  
Manonmaniam Sundaranar University, TN

DAAD Fellow (Germany)  
EMBO WP Fellow (Germany)  
UNESCO Fellowship Awardee (Italy)  
Mariecurie Fellow (EMBL)  
Chairman Associate – BRICS Biomed Consortium  
FOCAL POINT, European Commission HORIZON 2020

Free Registration @ <https://forms.gle/vCifjvCwTgCGrqlt8>

For Further Queries, Please Contact

Dr. J. JAYANTHI (CONVENER)  
DEAN RESEARCH, GNCR  
[researchdean@gurunanakcollege.edu.in](mailto:researchdean@gurunanakcollege.edu.in)



**Dr. M. G. RAGUNATHAN**  
Principal



**SARDAR MANJIT SINGH NAYAR**  
General Secretary & Correspondent

### 3. Photos

The Role of Transgenic fishes in Drug Discovery and the Scope for Entrepreneurship

Guru Nanak College

Webinar : October 01, 2020

Prof. Dr. S. G. PRAKASH VINCENT Ph.D (Indo-German)  
DAAD Fellow (Germany)  
EMBO WP Fellow (Germany)  
UNESCO Fellowship Awardee (Italy)  
MARIECURE Fellow (European Commission)

Focal Point  
European Commission HORIZON 2020

Chairman Associate (India)

Professor & HOD  
Central Institute of Marine Science and Technology (CIMST)  
Manipal Institute of Technology (MIT)

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Dr. MAHENDRAKUMAR. M

Dr. L.R.S. Kalanithi, Vice Principal (SA)

Dr. J. Jayanthi - Dean Research

Prof. Prakash Vincent

Powered by Stream Yard

Dr. L.R.S. Kalanithi, Vice Principal (SA)



**The Role of Transgenic fishes in Drug Discovery and the Scope for Entrepreneurship**

**Content**

Drug Discovery overview - Zebrafish-Medaka as Vertebrate model - Advantages-Genie Knockin-Construction of Transgenic Vectors-Microinjection - In vivo live Confocal Imaging - In situ Hybridization - Antisense RNA based knock down - Stable Gene Knock outs

Transgenic Fish models for Human Cancers, Organ toxicity, Angiogenesis, - High-throughput screening (HTS)

Entrepreneurial prospects: Identifying novel human disease targets- identification of human therapeutic drugs - Identification of novel peptides involved in organ growth- organ repair- prospects on mass production of Biologicals- Biosimilars in Transgenic Fish.

Dr. S.G. Prakash Vinayak

**Drug Discovery Overview**

Target Discovery - Overview  
Target Discovery - Disease Modulators  
Target Discovery - Disease Genes  
Target Discovery - Target Dope and "Targetivity"  
Target Discovery - Functional Genomics  
Target Validation - Overview  
Target Validation - Candidate vs. Out-of-Fraction Therapeutic Models  
Target Validation - Pathways  
Target Validation - Clinical Data  
Target Validation - Advanced DRUGS and RNAi  
Target Validation - Chemical Libraries and Chemical Biology  
Assay Development - Overview  
Assay Development - In Vitro Cell Based  
Assay Development - In Vivo Animal Models  
Assay Development - HTS  
Screening and Hit to Lead - Overview  
Screening and Hit to Lead - Compound Libraries  
Screening and Hit to Lead - Parallel and Combinatorial Chemistry  
Screening and Hit to Lead - Primary Screening  
Screening and Hit to Lead - Primary and Dose Response  
Screening and Hit to Lead - Compound and Sublibrary  
Screening and Hit to Lead - Application of Active DMVD  
Lead Collections - Overview  
Lead Collections - Methods and Chemistry  
Lead Collections - Assays: TOXPL, ADMET  
Lead Collections - Growth  
Lead Collections - Pharmacokinetics and Delivery  
Development - Overview  
Development - Preclinical Data Package  
Development - Process Development/CMC/AD  
Development - B2B Supply chain  
Clinical Trials - Overview  
Phase 1 - Overview  
Phase 1 - Safety and Dosage  
Phase 2 - Overview  
Phase 2 - Overview  
Phase 3 - Overview  
Phase 4 - Overview

15 years  
1 drug Rs. 18000 crores  
2.8 Billion USD

Dr. S.G. Prakash Vinayak

**Attributes of some key animals used to model human disease**

Attributes of disease model	Fly	Zebrafish	Mouse	Man
<b>Practical issues</b>				
Genetically tractable	5	5	110	110
Cost per animal per year	5	5	110	110
Physiological related studies	5	5	110	110
Cultural laboratory studies	5	5	110	110
Speed of maturity	5	5	110	110
Risks due to genetic instability	5	5	110	110
Biological complexity	5	5	110	110
Human homology (sequencing gaps)	5	5	110	110
<b>Molecular (single tools)</b>				
Transgenic?	5	5	5	5
Targeted gene modification?	5	5	5	5
Transposon insertion?	5	5	5	5
Adult males from T0 P0?	5	5	5	5
Flexibility of large scale breeding?	5	5	5	5
Flexibility of targeted alterations?	5	5	5	5
Sequence homology?	5	5	5	5
Genetically tractable?	5	5	5	5
<b>Cell biology tools</b>				
Cell lines and tissue culture	5	5	5	5
Antibody reagents	5	5	5	5

4D imaging

27 from 70% Orthologous genes of Human

Dr. S.G. Prakash Vinayak

## Gene Knock in

A knock-in (or gene knock-in) refers to a genetic engineering method that involves the insertion of DNA sequence information in a genetic locus, not found within the locus.

**Normally**

**with GFP As Tracer**

Prof. Prakash Vasant

Dr. S.G. Prakash Vasant

## Transgenesis

- \* Model organism - Transgenic Fishes
- \* Construction of mGFP, nRFP Vectors
- \* Microinjection
- \* Production of Transgenic Fishes
- \* 4D Imaging – Confocal microscopy

Medaka – *Oryzias latipes*

Prof. Prakash Vasant

Dr. S.G. Prakash Vasant

## Microinjection

Normal Medaka  
*Oryzias latipes*

Transgenic Medaka

Prof. Prakash Vasant

Dr. S.G. Prakash Vasant

Leica Confocal Microscope  
TCS SP2 AOBS FCS

WinemYard

Dr. S.G. Prakash Vincent

1 nm

Laser beam

z

3 D  
100.01 min

5ms

4 D microscopy  
100.05 min

Prof. Prakash Vincent

### In situ hybridization

The *in situ* hybridization (ISH) technique allows the sites of expression of particular genes to be detected.

This protocol describes ISH of digoxigenin-labeled antisense RNA probes to whole-mount zebrafish embryos. Embryos are fixed and permeabilized before being soaked in the digoxigenin-labeled probe.

WinemYard

Dr. S.G. Prakash Vincent

Blood and neural markers

stem cells in the intermediate cell mass  
lateral cranial cells

stem cells in the intermediate cell mass

head stage

translational vesicles  
muscle vesicles  
intermediate cell mass

reticulated

Chenarungs, S. P., Nurnick, J. A., High Resolution Visualization of Gene Expression within Zebrafish Embryos for Study Gene Expression and Function. *J. Vis. Exp.* (2014): doi:10.1038/56442 (2014).

Prof. Prakash Vincent

### Antisense RNA based Gene knock down

#### Morpholino

Gene knockdown by morpholino antisense nucleotide injection.

Chemical structure of part of a morpholino oligonucleotide.

Morpholinos are generally designed to bind to either the START codon (ATG), which results in a translational blockage (left), or a splice site (SS), which results in a misspliced mRNA and a defective protein (right).


Overview of the generation of knockdown phenotypes in zebrafish via injection of morpholinos. One-cell stage embryos of the F1 generation are injected with the morpholino and allowed to develop. The morpholino is typically co-injected with a dye (shown here in red) to allow monitoring of the amount injected. Depending on when the targeted gene is required during development, the injected embryos (morphants) show the knockdown phenotype.

WinemYard

Dr. S.G. Prakash Vincent

Prof. Prakash Vincent





Prof. Prakash Vincent

## Gene Knock out

**Guide Design with sgRNA**  
Lookup Table

↓

**Plotted in vitro Transcription**


↓

**Yolk-injection of Cas9 Ribonucleoprotein Complex**

↓

**G0 Phenotype Evaluation**

**Redundant Single Gene Targeting**




3 days

Time to

A single template elongation reaction using four primers, each containing a different "spacer" targeting sequence, was used to generate a mixture of four-guide templates that was in turn used in a single in vitro transcription reaction to produce a mixture of the four desired sgRNAs.

A system for **gene knock-out** that consistently produces null phenotypes in G0 zebrafish. Yolk injection of sets of four CRISPR/Cas9 ribonucleoprotein complex was redundantly targeting a single gene recapitulated germline-transmitted knock-out phenotypes in >90% of G0 embryos for each of 6 test genes. Early embryonic (6 hpf) and stable adult phenotypes were produced.

Yu et al 2010 Development (doi:10.1242/dev.137222)




Prof. Prakash Vincent


## Angiogenesis Screening

**Zebrafish embryo:**  
Blood vessel development

12 hpf      18 hpf      26 to 30 hpf




Lateral View



A tumor cell creating its own blood supply.

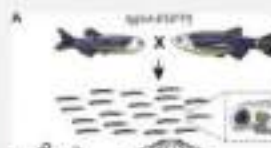
ICM, dorsal aorta; PCV, posterior cardinal vein; DV, dorsal venous sinus; DLV, dorsal longitudinal anastomotic vessel




Prof. Prakash Vincent

## T-cell lymphoblastic leukemia (T-ALL) – Drug Discovery


**A**



**B**



**C**



Validation assays

Zebrafish screen for inhibitor T-ALL therapeutics. G0 Adults carrying a transgene that fluorescently labels T cells (lox-EGFP) are mated. Resulting embryos have fluorescent T cells in the thymus (green spot in depicted embryo side view). Successful T cell in embryos are predicted to be similar to mammalian lymphomata.

25,000 day-old embryos are analyzed over 26 well plates and treated with different compounds from a small molecule library. Forty eight hours later, embryos are observed to determine general health, and examined for normal (all embryos) or decreased (right embryo) T cell numbers, under an indirect fluorescence. 20 Effective compounds are further verified and tested in follow-up assays.

They took advantage of a transgenic zebrafish line (lox-EGFP) carrying an EGFP transgene under the control of the T cell-specific lox promoter and treated embryos with library compounds to determine whether any had the capacity to block T-cell development, readily visualized by fluorescence in lox-EGFP fish.

Their survey of 25,000 small molecules revealed that a compound with previously unappreciated biologic activity, 1H-indole-3-carbaldehyde 5-quinolinylhydrazone, which they termed Lenalidomide (LDC), is able to specifically ablate immature T cells.

**Novel Hit/L lead can fetch to 10 million USD (INR 20 to 75 Crores)**

Wojcik et al Blood 2012 Jun 14; 119(24): 5021-5031

**Zebrafish with Human Cancer Genes And Screening**

Harvey et al 2014




Figure 1. Transgenic zebrafish melanoma and neural crest gene expression. Transgenic zebrafish expressing BRAF<sup>V600E</sup> and the melanocyte-specific mitf promoter develop pigmentation abnormalities, and melanoma when crossed with gata3<sup>lacZ</sup>.

Several cancer drug screens have been carried out in zebrafish.

For example, White et al. (2011) zebrafish embryos expressing the human BRCA1 oncogene and lacking the tumor suppressor p53 readily compensate for inhibitory expansion of neural crest progenitor cells, which give rise to melanoma.

**Zebrafish with Human Genes - Entrepreneurship Opportunity**

Dr. S. G. Prakash Vincent

**Cancer drug screens**

**Repurposing of Drug - Entrepreneurship Opportunity**

**Leflunomide**

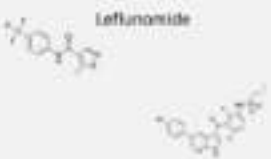

In a screen of 2000 small molecules, a predicted inhibitor of dihydroorotate dehydrogenase blocked progenitor expansion.

The known but structurally unrelated dihydroorotate dehydrogenase inhibitor leflunomide, which is used to treat arthritis, had the same effect.

Leflunomide combined with a BRAF inhibitor suppressed melanoma growth in xenograft mice.

Clinical trials of leflunomide combined with the BRAF inhibitor vemurafenib for treatment of melanoma are ongoing.

Dihydroorotate dehydrogenase Wikipedia

Dr. S. G. Prakash Vincent

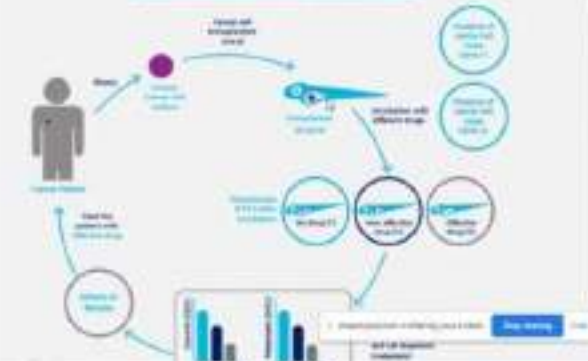
**ZeClinics**

**ZeOncoTest**

**Personalized Cancer Treatment**


**Epilepsy**

Spain-based CRO ZeClinics to commercialize a zebrafish model for childhood epilepsy that mimics the convulsive behavior and seizures associated with epilepsy. The model has a proven track record in successfully identifying new treatments against epileptic disorders and already has three compounds in Phases 1 and 2 clinical trials.




Dr. S. G. Prakash Vincent

## Kidney regeneration




Prof. Prakash Vincent

Reactivation of genes normally expressed during organogenesis is a characteristic of kidney regeneration. Enhancing this reactivation could potentially be a therapeutic target to augment kidney regeneration.




Kidney regeneration is characterized by dedifferentiation of surviving renal tubular epithelial cells into progenitor cells, associated with reactivation of genes normally required during organogenesis.<sup>12,13</sup>

One of the genes reactivated during regeneration is the Lim homeobox protein, *Lhx1* (formerly *Lim1*), which is essential during embryonic development for establishing the kidney field.



UPH4031



Embryo    200-100    300-100    4-100

UPH4031

**Development of High-Content Assays for Kidney Progenitor Cell Expansion in Transgenic Zebrafish**

Subramanian, Sankar<sup>1</sup>, Maria-Felicia, Chiu<sup>1</sup>, Laura L. Walker<sup>1</sup>, Benjamin Goldberg<sup>1</sup>, Lee A. McDermott<sup>1,2</sup>, Mark A. Haberman<sup>1,2</sup>, and Andrew Vogel<sup>1,2</sup>

1 Department of Cell Biology and Biophysics, Harvard Medical School, Boston, MA 02115  
2 Department of Cell Biology, Harvard University, Cambridge, MA 02138

UPH4031

## Cardioprotectant



Prof. Prakash Vincent

One such example is highlighted on the right. A compound (SB2) identified in a zebrafish screen for suppressors of a plakoglobin mutant phenotype reduces the ventricular ectopic activity seen in a mouse model of the same desmosomal mutant protein.


In addition, the same compound rescues contractile abnormalities and conduction abnormalities observed in a mouse model of the related disorder caused by mutations in the desmoglein2 gene.



Baron-Kilmer, and Calum A. MacRae. *BTS* 2017;2:5-12

JACC

## Target Discovery




Prof. Prakash Vincent

One of the most common cancers in children and adolescents is rhabdomyosarcoma, a cancer of soft tissue such as muscle, tendon or cartilage. The fusion of DNA on two different chromosomes causes the most aggressive form of rhabdomyosarcoma. The fused DNA produces an abnormal protein called PAX3-FOXO1.

**Novel Target could fetch 10 to 30 million USD (INR 75 to 225 Crores)**

*Ier3* is a novel developmental target of human PAX3-FOXO1

The PAX3/7-FOXO1 oncogenes remain intractable to therapeutic targeting, impeding the development of effective precision medicine therapies



Inject at 1-cell    Plasmid DNA    Transposase mRNA    Sort GFP+ embryos    Collect Tumors

1 Department of Cell Biology and Biophysics, Harvard Medical School, Boston, MA 02115

**Stream Yard**

**High-Throughput Screening**

Zebrafish are an emerging vertebrate model for HT toxicity screening, disease modeling, phenotype discovery, and chemical mechanisms of action. Their high fecundity, low cost, and rapid development make nearly all *in vivo* biological assays amenable to HT studies. As assays and endpoints become more standardized with the use of modern technologies, the zebrafish has rapidly become one of the premier vertebrate models for biological discovery. *HT* high-throughput

High 2007, Pinsky 04, & Pascher & Zebrafish  
Genetic Toxicology: Sun Biol Health 0071, 341-352

Dr. S.G. Prakash Venkier

**Stream Yard**

Zebrafish assays have been accepted by the Food and Drug Administration for toxicity and safety assessments for investigative new drug approval (He et al., 2014).

## FDA and EU

European Union (EU) ban on the sale of animal-tested cosmetics, in force since 2013, which reduces testing options to *in vitro* models

broader effort to reduce, refine, and replace the use of animals in toxicity assays (otherwise known as the 3Rs initiative)

Directive 2010/63/EU of the European Parliament regulates that zebrafish larvae up to 5 dpf are classified as *in vitro* models. Therefore, for all practical purposes, it is accurate to regard zebrafish embryos as 3Rs-compliant.

Dr. S.G. Prakash Venkier

**Stream Yard**

## CONTRACT RESEARCH ORGANIZATION (CRO) SERVICES

Global Contract Research Organization Services Market (US\$ Mn), 2018-2028

Global Contract Research Organization Services Market (US\$ Mn), 2018 to 2028

2018: 120,356.4 Million  
2020: 150,000.0 Million  
2022: 180,000.0 Million  
2024: 210,000.0 Million  
2026: 240,000.0 Million  
2028: 270,000.0 Million

Market Segmentation by Service Type (2018):

- Clinical: 44.3%
- Discovery: 34.3%
- Pre-Clinical: 14.3%
- Laboratory Services: 8.1%

Discovery – 15 Billion USD- Rs. 1.2 Lakh Crores

Preclinical – 10 Billion USD- Rs. 75,000 Crores

**IS SPACE**

Dr. S.G. Prakash Venkier

**Entrepreneurship Opportunities**

Zebra fish Embryos

Antibodies to Zebrafish proteins

Zebrafish Knockout 500 nos

Zebrafish based Preclinical research

Hit discovery using Zebrafish Screening

Target discovery using Zebrafish

Discovery – 15 Billion USD- Rs. 1.2 Lakh Crores

Preclinical – 10 Billion USD- Rs. 75,000 Crores

**STARTUPS**

Potential exist for 100 STARTUPS - Zebrafish based Startups in India by 2025

Dr. S. G. Prakash Vincent

**Drug Discovery Startups in India**

STARTUP INDIA  
SEARCH FOR TALENT

Global Major Pharma out-licensing Clients

AbbVie Laboratories  
AstraZeneca Ltd.  
Amgen Inc.  
Aurobindo Pharma  
Bayer HealthCare AG  
Boehringer Ingelheim  
Catalent Pharmaceuticals Inc.  
Daiichi Sankyo Company Ltd.  
Eli Lilly and Company  
Gilead Sciences Inc.  
GlaxoSmithKline Plc  
Genzyme Pharmaceuticals  
Hoffmann-La Roche Ltd. Johnson & Johnson  
Ligand Pharmaceuticals Inc.  
Merck & Co. Inc.  
Novartis AG  
Pfizer Inc.  
Roche-Genentech Inc.  
Schering-Plough Corp.  
Veeva Systems Inc.  
Wyeth Pharmaceuticals Inc.  
Zentiva Pharmaceuticals Ltd

STARTUP Revenue Streams

- License payments
- License payments
- R&D payments
- Phase-out payments
- Royalties
- Equity Investments

CRQs for

Normal Hit/Lead can fetch 1 to 15 million USD (INR 20 to 75 Crores)

Normal Target could fetch 1 to 20 million USD (INR 75 to 225 Crores)

Target

Hit/Lead

Dr. S. G. Prakash Vincent

**To Summarize**

Dr. S. G. Prakash Vincent



A screenshot of a Zoom meeting with three participants. The participant on the left is Sangram Keshari Panda. A chat bubble is visible in the bottom left corner.

**SANGRAM KESHARI PANDA**

Which drugs are already prepared by using the transgenic fishes & for which diseases ??



A screenshot of a Zoom meeting with three participants. The participant on the left is Manikandan B N. A chat bubble is visible in the bottom left corner.

**Manikandan B N**

how to differentiate a normal fish from transgenic fish....what is the selectable markers used....for drug production in transgenic fish

## 4. Certificate Copy



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“THE ROLE OF TRANSGENIC FISHES IN DRUG DISCOVERY  
AND THE SCOPE FOR ENTREPRENEURSHIP”

### Certificate of Participation

*This is to certify that*

**Dr. GEETANJALI RANA KANWAR**

*G. B. Pant University of Agriculture and Technology,  
Pantnagar, Uttarakhand*

has actively participated in the NATIONAL WEBINAR ON  
“THE ROLE OF TRANSGENIC FISHES IN DRUG DISCOVERY AND  
THE SCOPE FOR ENTREPRENEURSHIP” held on 01.10.2020 organized  
by the GURU NANAK CENTRE FOR RESEARCH (GNCR),  
GURU NANAK COLLEGE (AUTONOMOUS), Guru Nanak Salai,  
Velachery, Chennai – 600042.

**Dr. J. JAYANTHI**  
DEAN RESEARCH & CONVENER

**Dr. M. G. RAGUNATHAN**  
PRINCIPAL

**SARDAR MANJIT SINGH NAYAR**  
GENERAL SECRETARY & CORRESPONDENT