List of faculties who desire to take students

Dr. Subeer S. Majumdar

Dr. Majumdar's lab works in the field of animal biotechnology, genomics and transgenic technology. His present research focus lies in the fields of

1. Production of therapeutic proteins for animal and human in the milk by genetic engineering using targeted gene delivery/expression in tissue specific manner for reducing cost of treatment.
2. New Methods of transgenesis for biomedical research including generation of transgenic animals for mimicking pathophysiological conditions of human and animal diseases.
3. Livestock genomics using NGS and SNP chip development for herd improvement.
4. Alternative to knock out technology, utilizing shRNA to generate transgenic animals.
5. Coordinating and PI in One Health consortium initiative of India.
6. Coordinating flagship program of DBT on creating host-pathogen interaction platform at NIAB.

Dr. Nagendra Hegde

Dr. Hegde's laboratory is interested in host-pathogen interaction and immunology. He has in the past worked on viruses and bacteria of importance to animals and humans, covering topics such as epidemiology, genomics, host-pathogen interactions, vaccines and diagnostics. His current and future interests include mechanisms of viral and bacterial biology and pathogenesis, fundamental immunology in livestock species, and vaccines, diagnostics and anti-microbials and anti-virals for some of the important diseases of livestock as well as zoonoses. The laboratory applies techniques such as genome analysis and genetic manipulation, cloning and mutagenesis, protein expression and purification, protein-protein interactions, recombinant viral vector generation, immune responses and systems immunology, and omics approaches. Specific pathogens include mastitis-associated bacteria, DNA and RNA viruses of livestock, and pathogens that are transmitted from animals to humans. Currently, the lab has active projects on the biology of ephemeroviruses, biofilm formation by mastitis-associated staphylococci and a multi-disciplinary approach to understand and design interventions for anti-microbial resistance in poultry. The laboratory works in collaboration with other researchers at state, national and international levels to accomplish the goals, and is funded through national and international grants.

Dr. Ravi Kumar Gandham. V. P. P. S.

Host Pathogen Interaction (JE – Human vs Pig)

Viremia is caused by the replication of viruses which results in viruses being introduced into the bloodstream. Domestic pigs are the major amplifying host for Japanese encephalitis (JE) virus transmission to humans, because they develop high titers and long-lasting viremia after natural infection. Humans, horses, and other non-avian vertebrates are considered dead-end hosts because

they do not produce a level of viremia sufficient to infect new mosquitoes. With high titers of virus in the blood, pigs rarely show symptoms and humans with low levels of the virus in blood are affected. This differential host response will be explored by transcriptome (mRNA, miRNA, lncRNA, epitrancriptome and Circular RNA) and proteome analysis in the project that is taken up at our Institute.

Dr. Syed M Faisal

Our lab is well equipped with state of art infrastructure facility and ample opportunity for personal development. Students are encouraged to choose the research topic of their interest from various ongoing projects. The research in our lab is both basic and applied and mainly focused in two areas.

1. ***Finding new avenues for developing effective vaccines and diagnostics against Leptospirosis.*** Leptospirosis is a zoonotic and re-emerging infectious disease of global importance. Little is understood about *Leptospira* pathogenesis and host responses which has hampered the development of new intervention strategies. Using Omics (Transcriptomic and Proteomics) we are trying to understand how *Leptospira* interacts with various host to identify the critical factors of both pathogen and host which are involved in establishing infection and host defense. We are trying to characterize surface molecules (protein, LPS) to understand their role in evasion from innate immunity. Our group is exploiting innovative technologies different from conventional methods for developing subunit, live attenuated (using CRISPR/Cas9 technology) and Conjugate vaccines agaisnt this dreadful zoonosis.
2. ***Development of novel vaccine adjuvants.*** Another area of our research is on Adjuvant design and development. Adjuvants are crucial to success of vaccines**.** Research effort in our lab is focused on enhancing the potency of existing adjuvant or develop new adjuvant formulations. We are trying identify novel chemical/herbal/peptide immunomodulators or TLR agonists that can be incorporated in suitable delivery vehicle to develop adjuvant systems (combination adjuvants). Using computational approaches, we aim to design or engineer effective vaccine adjuvants and understand their mechanism of action both in vitro and in relevant animal model (Systems Vaccinology). Using large animal model (goats, cattle) we envisage to study long term immune response (including memory) induced by various vaccines. The ultimate aim is to develop cost effective adjuvant that is easy to manufacture, provide long-term immunity, non-toxic and can be given orally.

Dr. Prasada Rao

Mammalian oocytes can be very long-lived cells. Consequently, throughout their lifespan, they are highly likely to experience DNA damage. Failure to detect and repair this DNA damage, or trigger cell death to remove damaged oocytes, could cause severe problems that result in embryonic death or congenital disorders. Given the fact that each human cell undergoes ~ 70000 lesions per day.

The majority of lesions (75%) are single-strand DNA (ssDNA) breaks, which can arise from oxidative damage during metabolism or base hydrolysis. ssDNA breaks can also be converted to DNA double-strand breaks (DSBs), which although much less frequent, are more dangerous. Despite the importance of DNA damage for reproductive capacity, the molecular mechanisms in oocytes remain poorly characterized. My lab is interested in studying the Molecular mechanisms of DNA damage and repair which may leads to treatment strategies for the reproductive problems. Particularly, I am interested in DNA repair pathways during gametogenesis, oocyte atresia by using CRISPR tools.

Dr. Pankaj Suman

Suman Laboratory is interested in understanding the molecular interactions of G-quadruplex forming oligonulceotides (aptamer) and small target molecules using advanced techniques like digital droplet PCR, LC-MS, CD-Spectropolarimetry, surface plasmon resonance (SPR), microscale thermophoresis (MST), isothermal titration calorimetry (ITC), NMR, molecular docking and simulations. The studies have been designed in such a way that the basic research is being translated into field applicable, farmer centric technologies to develop affordable diagnostics and therapeutics.

The Suman lab brings together interdisciplinary experimental approaches at the interface of biomedical science, chemistry and engineering to tackle major challenges in animal health and production. A dynamic collaborative research team is handling projects aiming to develop technologies in a variety of contexts, including point-of-care testing of venom upon snake bite, antibiotic and microbes detection, continuous hormone sensing for reproductive disorders, PVA/Chitosan based microneedle and injectable nanofibrous implant for transdermal hormone delivery, engineering cellulosomal enzyme complex in the form of nanozymes to enhance breakdown of cellulose (present in plant) into simple sugar moieties. In past, his basic research efforts have led to development of a versatile method for aptamer selection and characterization without need of high end equipments and facilities. Using this technology, several field applicable and farmer centric products have been developed that include an aptamer based lateral flow device for detection of antibiotic (oxytetracycline) in milk and meat, diagnostic kit for early detection of subclinical mastitis and microbial quality of milk, point-of-care diagnostics for differential detection of snake venom using antibodies and aptamers.

Dr. Nirmalya Ganguli

Theme of research of my laboratory is generation of transgenic animals or animals with somatic genomic modification for using them as bioreactor for generation of biotherapeutics and nutraceuticals as well as a model system for the study of functional genomics of farm animals. We are also working on Germ cell/ Stem cell transplantation studies to explore avenues for production of sperm with elite characteristics.
We have established methods for generation of transgenic mice and working on extrapolating the same to establish new easier techniques for making transgenic farm animals. We are also working

on developing new methods for direct transfection of mammary gland to alter the somatic genome of the mammary epithelial cells by CRISPR-Cas9 mediated genome engineering technique. To use these technologies for generating animal bioreactor expressing biotherapeutics for human or animal in the milk for easy extraction process, increasing its affordability. We have developed easy method of evacuation of testis from spermatogonial stem cells (SSC) in mice followed by transplantation and repopulation of isolated and cultured SSC in it. We are adopting the same technology for germ line genomic modification through multiplex CRISPR-Cas9 mediated genome engineering for production of sperm with elite trait (transgenic sperm). We are planning to undertake Next Generation Sequencing (NGS) of whole transcriptome from Mammary Gland of Indian Goat for detecting differentially expressed mRNA/Micro RNA (miRNA)/Long noncoding RNA (lncRNA) in different lactational time followed by Functional Genomics Study of such transcripts in transgenic mice models. Along with this we are routinely working on generating multi-cistronic mammalian expression vector through synthetic biology approach for ubiquitous and cell/tissue specific expression of desired gene, which are used for generation of transgenic mice model to addresses various problems related to production and reproduction in farm animals as well as to study farm animal functional genomics.

Dr. Sandeep Kushwaha

Broad research focus of Kushwaha's lab: a) to develop biological and computational resources to support livestock research in India (b) to develop methods to identify general disease resistance and environmental adaptation potential of individuals by using advance molecular and computational techniques to enhance genetic improvement in livestock production systems.
Current research themes:
Comparative genomics to identify molecular genetics factors of *Malnad gigda* breed for FMD tolerance: Foot and mouth disease (FMD) has a wide range of infection in livestock animals and infect all kind of breeds of cattle except *Malnad gigda*, a native breed of Karnataka, India. Various kinds of research have been done to understand the molecular mechanism of FMD pathogenesis, progress, and FMD vaccine performance and protection. Yet, FMD infection, and cause of short term resistance is poorly understood. So far, no study have been reported to reveal molecular genetics factors for FMD tolerance in breed *Malnad gigda*. Computational and molecular biology tool and techniques will used to detect both known and novel molecular factors and variants associated with FMD tolerance in breed Malnad gigda.

Pan-genomics for Bovine mastitis pathogenesis and treatment
Bovine mastitis is one of oldest known diseases in cattle which is responsible for major economic losses of the dairy industry. Bovine mastitis aetiology is associated with approximately 150 different microorganisms, yet the influence of pathogen diversity on bovine mastitis is poorly understood due to technical limitation of detection methods. Pan genome analysis of mastitis causing pathogens will be explored for the detection and characterization of new strains, virulent and nonvirulent strains, pathogenic evolution, and drug target identification and vaccines development. Generated information will be utilized to identify molecular factors and variants associated with bovine mastitis; whether particular bacterial species/strain/substrains of pathogens are associated with disease or not, and finding will be validated through molecular biology techniques.

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Dr. Bappaditya Dey

Dr. Dey's laboratory is focused on research in the molecular basis of tuberculosis (TB) pathogenesis, host-pathogen interaction and molecular signaling, study of immunology and vaccine development. Dey-lab is exploring new strategies to combat the antimicrobial resistance (AMR) by identifying alternative drug targets involved in biofilm formation and peptidoglycan homeostasis. In addition, his group is also probing the potential of microbiome guided engineered autologous organ specific probiotics as novel prophylactic and therapeutic agent against mono and polymicrobial infections. Dey-lab employs multifaceted approaches including modern genetic engineering, genomics, proteomics, cell & tissue culture technology and animal models to understand, explore and utilize science towards improved diagnostics, drugs and vaccines against infectious diseases.

Dr. Abhijit S. Deshmukh

Research interest: *Molecular Parasitology and Host-parasite interaction*
We study the protozoan parasite *Toxoplasma gondii* causes disease Toxoplasmosis. This parasite is found in one-third of the world population and is capable of infecting any nucleated cell with a wide range of mammalian and avian hosts, making it one of the most successful parasites on earth. The infection in domestic animals causes abortion and leads to greater economic losses to livestock production. In humans, it causes lethal disease in the immunocompromised individuals, and in the developing foetus. We use a broad array of biochemical, cell biological, genetic and genomic approaches to understand fundamental Toxoplasma biology and use this knowledge to identify and develop targets for disease intervention.

Cell cycle and transcription
Toxoplasma gondii tachyzoites (highly multiplying stage) undergo asexual replication and produces two parasites per mitotic cell cycle, this process is called as endodyogeny. This mechanism involves the development of two daughter cells within a mother cell (Fig. 1), which is consumed by the offspring upon their maturation. The Toxoplasma cell cycle is composed of three phases: G1, S and M with G2 phase being brief or absent. Data mining of the Toxoplasma genome has revealed limited repertoires of Crks and cyclins. We identified and characterized two Crk proteins, Crk7 and Crk9 in *T. gondii*. While Crk7 kinase is important for transcription initiation, the kinase activity of Crk9 is essential for transcription elongation. Given the absence of a full repertoire of canonical CDKs and cyclins in Toxoplasma, the role and relevance of these proteins merit investigation. Current research focuses on understanding the unique cell cycle of Toxoplasma using a wide array of approaches, including protein biochemistry, cell biology and genetics. The research is directed towards identifying potential drug targets to intervene parasite progression.

Dr. Anand Srivastava

Dr. Srivastava's laboratory is interested in Tick and Tick borne diseases (TTBDs) and in the Immunology of ruminants. He has vast research experience in parasitic diseases like Malaria and

other protozoal parasites. His lab is presently focusing on Theileriosis, TTBDs and Systems Immunology where he is working in the areas such as host-pathogen interactions, vaccines, diagnostics and drug discovery. The current interests of his laboratory include:

1. Understanding of parasite factors involved in transformation of host cells.
2. Understanding the role of various kinases in *Theileria annulata* for transformation of host cells.
3. Developing herbal formulations as acaricides.
4. Understanding immunology of ruminants.

His laboratory regularly uses techniques like cloning & mutagenesis, protein expression & purification, genetic manipulation, bioinformatics, protein-protein interactions, Yeast two hybrid techniques, Proteomics and transcriptomics. The incumbent will be allowed to choose topic of his research in the broad areas as mentioned above.

Dr. Sandeep Goel

Mesenchymal stem cell-based therapy in livestock and companion animals: Cryo-banking for broad-spectrum clinical approach

Mesenchymal stem cell (MSC)-based therapy is a promising treatment in the repair and regeneration of injured and pathological tissues especially in the healing of long bone fractures and deep muscular wounds. Even if this innovative therapy in veterinary medicine is still limited, stem cell technology has attracted attention and is a quickly evolving field, among companion animals and livestock species, due to the limitations of pharmacological and other current therapeutic strategies. The clinical application of autologous or allogeneic MSCs requires a ready off-the-shelf amount of viable cells that maintain unaltered the characteristics of the freshly isolated samples. MSCs derived from all tissue sources have potent immunomodulatory capabilities in vitro. Autologous and allogeneic MSCs are non-immunogenic, and completely unmatched MSC do not induce leukocyte proliferation in the absence of activation in vitro (Poncelet *et al.* 2007; Mrugala *et al.* 2008; Carrade *et al.* 2012). Although the long experience of cell processing facilities, the consensus is lacking on a universally accepted method for the effective cryopreservation protocol of MSCs and on the maximum time of cryopreserved storage. For these reasons, even if several successful clinical results have been reported by several groups, the methods of stem cell cryo-banking need to be improved and the protocols standardized, before a broad spectrum of clinical applications can be successfully achieved. Therefore the current proposal aims to develop culture and characterization of allogeneic and autologous MSCs, their long-term cryopreservation to develop MSC cryo-banking that can aid in the broad-spectrum clinical application in livestock and companion animals.

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