**Development of frameworks for evidence-based practice of traditional medicine in integrative medicine settings**



**IntegratingTraditional Knowledge in Evidence Based Medicine**
pGI January 7-10 2024

Mitali Mukerji, PhD, FASc, FNASc
Professor & Head,
Department of Bioscience & Bioengineering
Affliate Faculty, School of Artificial Intelligence and Data Science (AIDE)
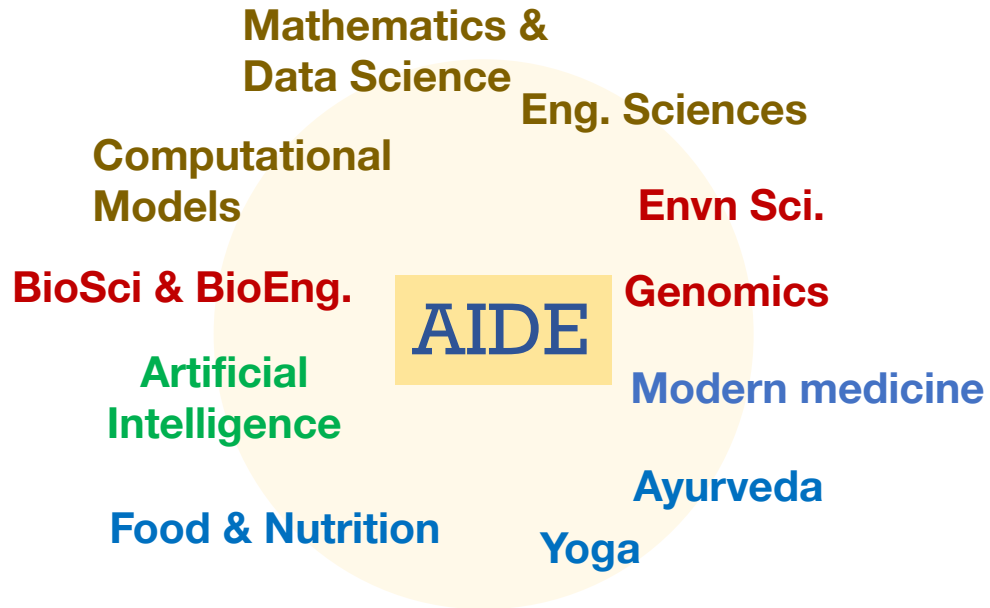Indian Institute of Technology Jodhpur
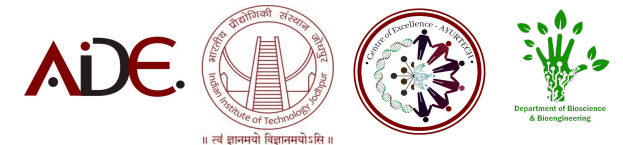
# Transdisciplinary Centre of Excellence in Integrative Precision Health

## Aim

**Establishment of AI driven integrative framework for population and individual risk stratification and early actionable precision health interventions**

Mathematics &
Data Science

Eng. Sciences

Computational
Models

Envn Sci.

BioSci & BioEng.

Genomics

AIDE

Artificial
Intelligence

Modern medicine

Food & Nutrition

Ayurveda

Yoga

**The School of <u>A</u>rtificial <u>I</u>ntelligence & <u>D</u>ata Scienc<u>E</u> (AIDE) would nucleate a transdisciplinary framework that would have application in:**

- Phenomics based non-invasive risk stratification
- Integration of principles and practice of Ayurveda with other knowledge systems
- Management of rare disease and common disease
- Development of an objective framework for Integrative medicine
- Precision health with specific focus in arid regions

# Integrative medicine_ a win-win situation

*Reactive -target symptoms*
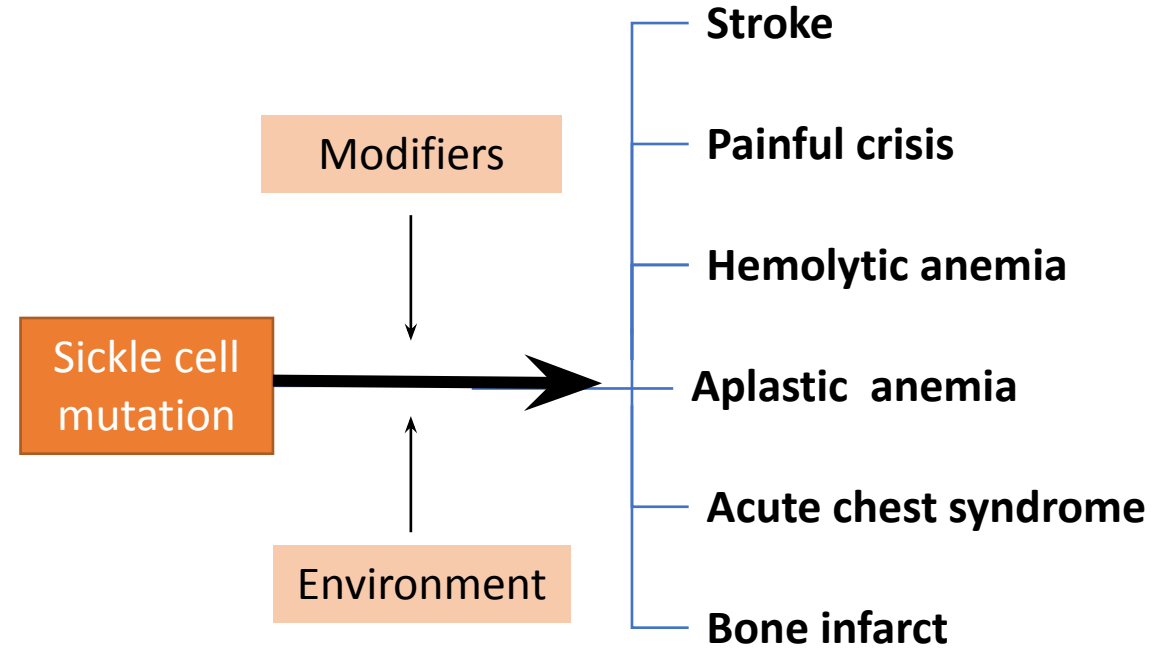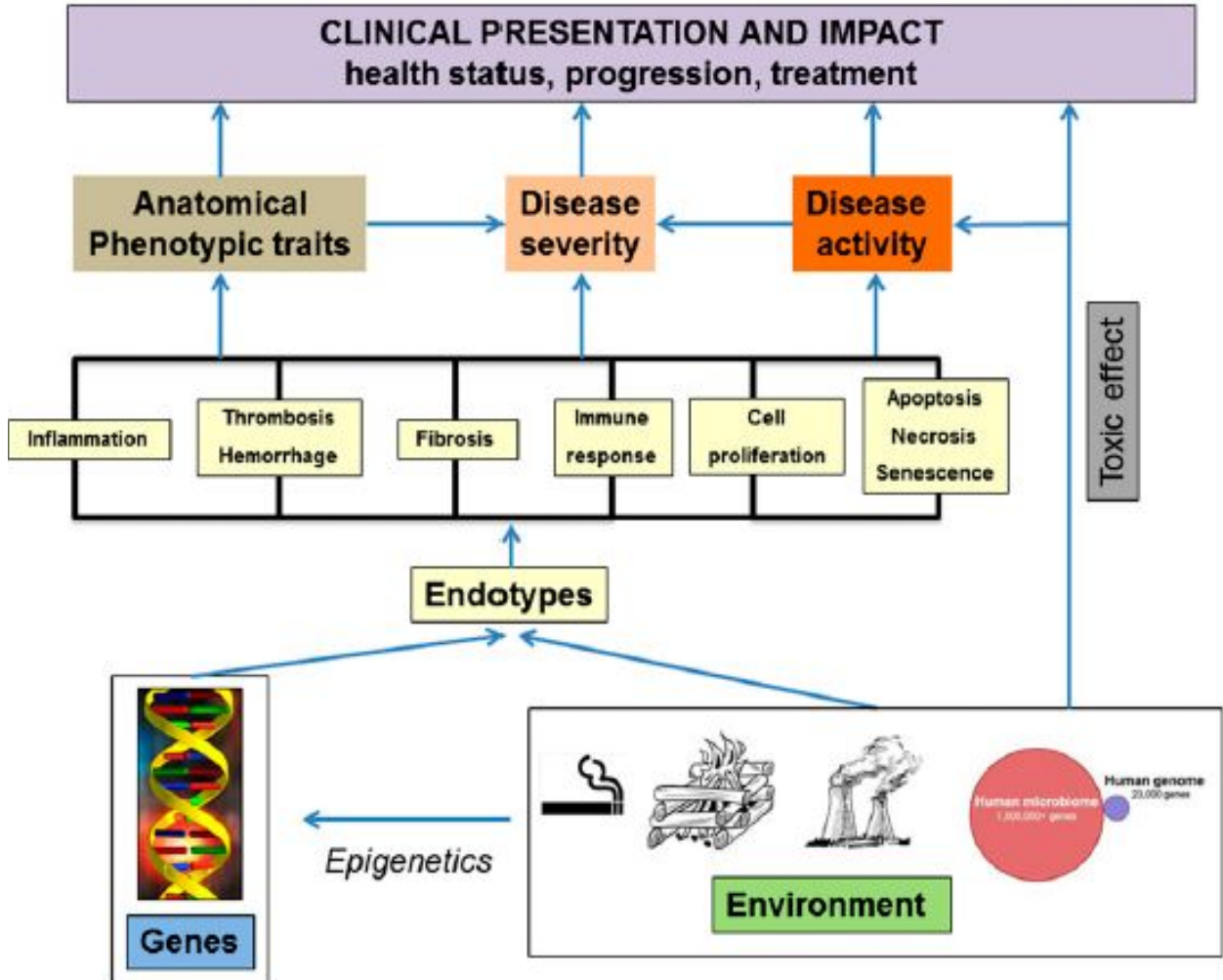*Treat molecular imbalances - organ specific*
*Specific molecules*

MODERN MEDICINE

*Proactive – targets doshic imbalances*
*Aims at reversal - system's perspective,*
*Poly-pharmacology*
*Holistic & individualized, based on Prakriti*

AYURVEDA

Ayurveda

Integrative

Modern Medicine
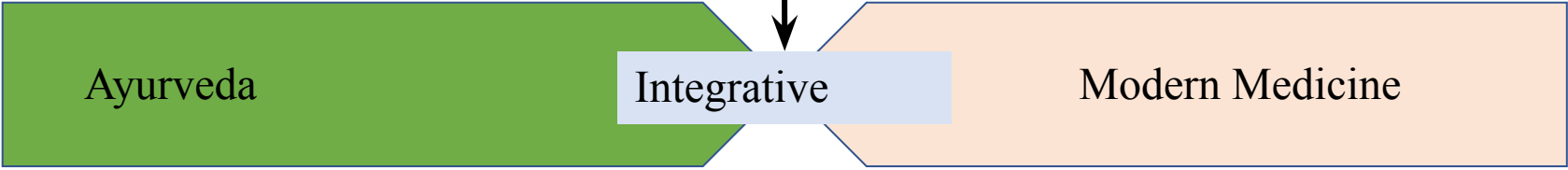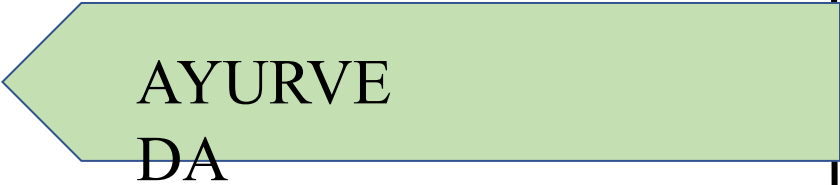
**Interoperable, complementary, synergistic, personalized options**

# Stratification in disease management

## Converging themes in diseases



CLINICAL PRESENTATION AND IMPACT
health status, progression, treatment

Anatomical Phenotypic traits

Disease severity

Disease activity

Toxic effect

Inflammation | Thrombosis Hemorrhage | Fibrosis | Immune response | Cell proliferation | Apoptosis Necrosis Senescence

Endotypes

Human genome 20,000 genes

Human microbiome 1,000,000+ genes

Epigenetics

Genes

Environment

(Shatkryikala ?)

Modifiers

Sickle cell mutation

Environment

Stroke

Painful crisis

Hemolytic anemia

Aplastic anemia

Acute chest syndrome

Bone infarct

**Challenges**
- **Modifiers ?**
- **Endophenotypes?**
- **Targeted interventions ?**

(Samprapti ?)

# A Paradigm shift from population based to individualized approach

**Population response based**

**Personalised**



**IMPRECISION MEDICINE**
For every person they do help (blue), the ten highest-grossing drugs in the United States fail to improve the conditions of between 3 and 24 people (red).

1. **ABILIFY** (aripiprazole) — Schizophrenia
2. **NEXIUM** (esomeprazole) — Heartburn
3. **HUMIRA** (adalimumab) — Arthritis
4. **CRESTOR** (rosuvastatin) — High cholesterol
5. **CYMBALTA** (duloxetine) — Depression
6. **ADVAIR DISKUS** (fluticasone propionate) — Asthma
7. **ENBREL** (etanercept) — Psoriasis
8. **REMICADE** (infliximab) — Crohn's disease
9. **COPAXONE** (glatiramer acetate) — Multiple sclerosis
10. **NEULASTA** (pegfilgrastim) — Neutropenia

Based on published number needed to treat (NNT) figures. For a full list of references, see Supplementary Information at go.nature.com/4dr78f.
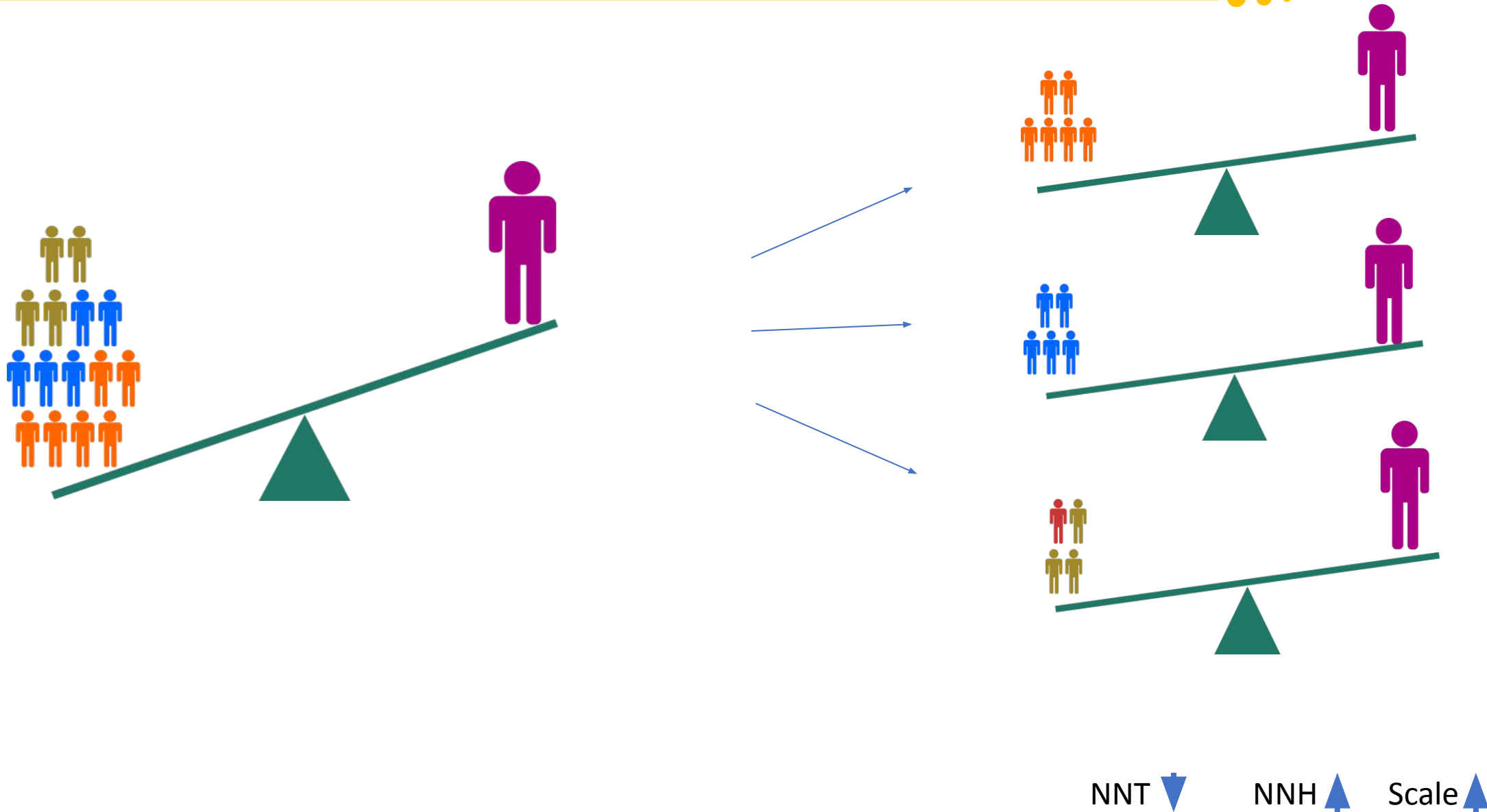
30 APRIL 2015 | VOL 520 | NATURE | 609

## Time for one-person trials

Precision medicine requires a different type of clinical trial that focuses on individual, not average, responses to therapy, says **Nicholas J. Schork**.

# Gap in knowledge : Health Stratification and Affordability



NNT ▼   NNH ▲   Scale ▲

# Definition of Genetic individuality - Modern vs Ayurveda

*Human Genome Project Surprises*

*There is no "The HUMAN Genome"*

**ESSAY**

GENOME-SEQUENCING ANNIVERSARY

## A Celebration of the Genome, Part III

## What Does a "Normal" Human Genome

Praus et al. Journal of Translational Medicine (2023) 21:41
https://doi.org/10.1186/s12967-022-03855-0

Journal of Translational Medicine

emag.org

**RESEARCH**  **Open Access**

Check for updates

## Panomics reveals patient individuality as the major driver of colorectal cancer progression

Friederike Praus[1†], Axel Künstner[2†], Thorben Sauer[1], Michael Kohl[1,2], Katharina Kern[1], Steffen Deichmann[3], Ákos Végvári[4,5], Tobias Keck[3], Hauke Busch[2], Jens K. Habermann[1,6] and Timo Gemoll[1*]
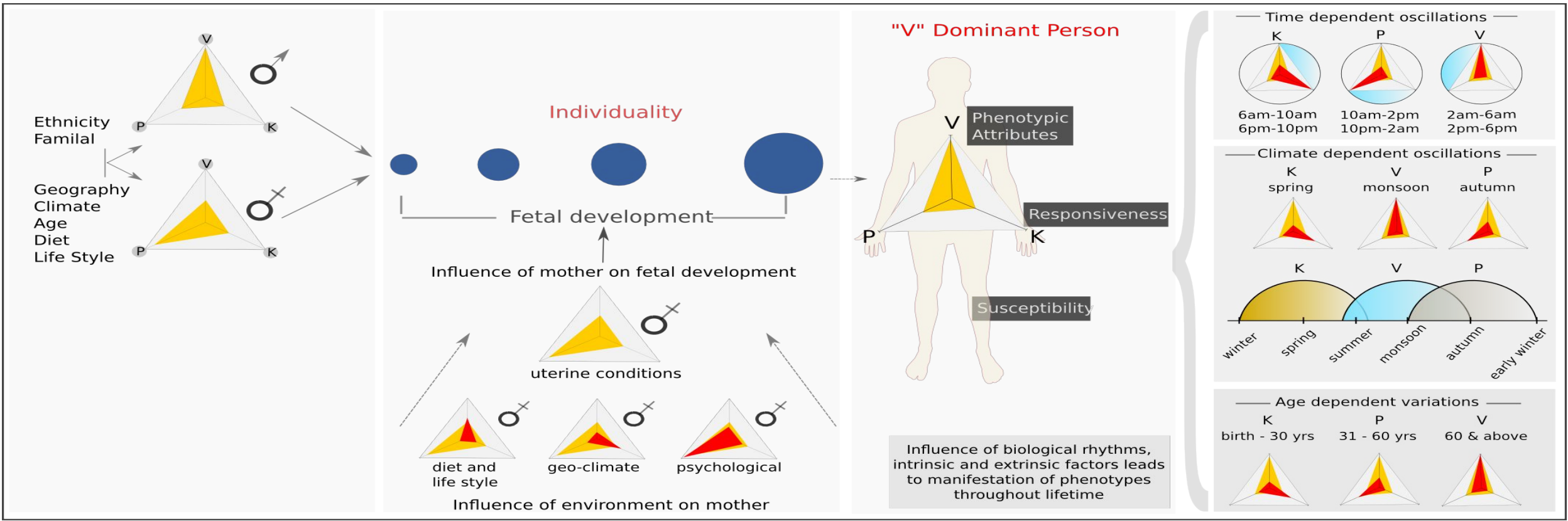
## 7 Prakriti types in a population
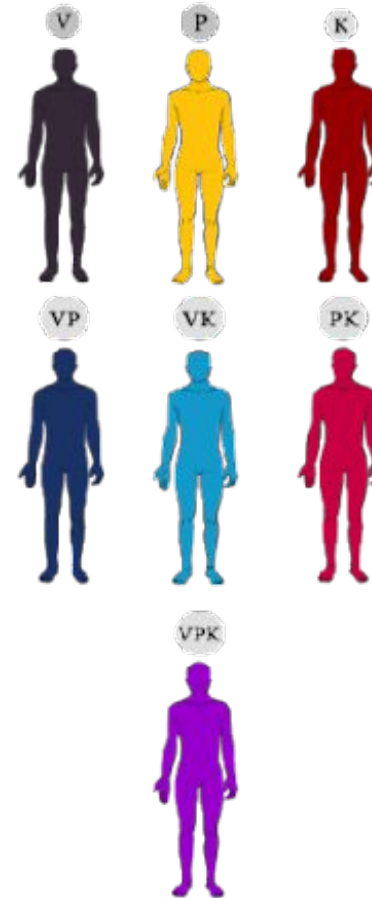


- **Health**
- **Response**
- **Disease Trajectory**
- **Individualised management**

*Prasher B., Gibson G. and Mukerji M. 2016 Genomic insights into ayurvedic and western approaches to personalized medicine. J. Genet. 95, 209–228*
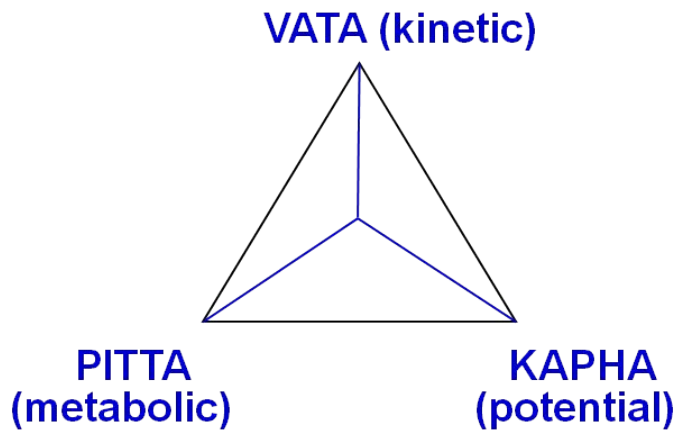
# Prakriti - GIS of an individual



शुक्रशोणितसंयोगे यो भवेद्दोष उत्कट: ॥
प्रकृतिर्जायते तेन तस्या मे लक्षणं शृणु ॥६३॥

**genetics**

तत्र प्रकृत्यादीन् भावाननुव्याख्यास्यामः । तद्यथा—शुक्रशोणितप्रकृतिं, कालगर्भाशयप्रकृतिं,
आतुराहारविहारप्रकृतिं, महाभूतविकारप्रकृतिं च गर्भशरीरमपेक्षते । एतानि हि येन येन दोषेणाधिके-

**epigenetics**

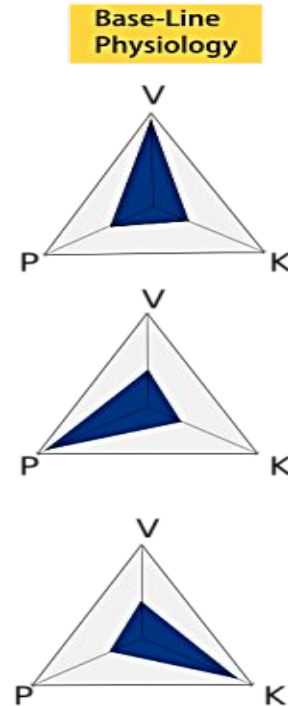**ethnicity** **familial** **geography** **time** **age**

तत्र प्रकृतिर्जातिप्रसक्ता च, कुलप्रसक्ता च, देशानुपातिनी च, कालानुपातिनी च, वयोऽनुपातिनी
च, प्रत्यात्मनियता चेति । जातिकुलदेशकालवयःप्रत्यात्मनियता हि तेषां तेषां पुरुषाणां ते ते भावविशेषा
भवन्ति ॥ ५ ॥

**Individual variation**

c. ı.1/5

# Tridoshas: Functional attributes

Tridosha

Doshas in Prakriti

Application of Dosha understanding in Trisutra

**VATA (kinetic)**

**PITTA (metabolic)**
**KAPHA (potential)**

Base-Line Physiology

V
P    K

V
P    K

V
P    K

Causes (*Hetu*)

Therapeutics (*Aushadha*)    Clinical features (*Vikruti*)
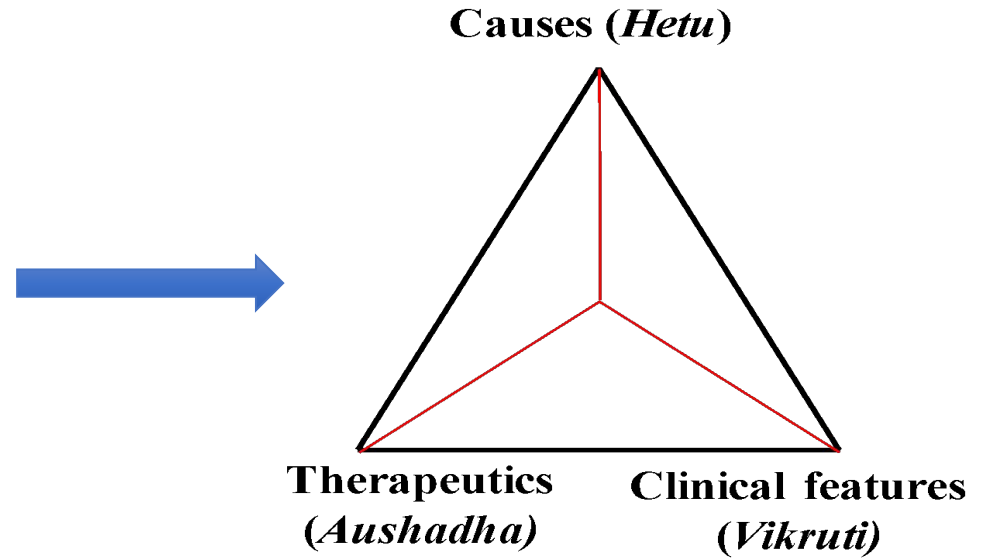
**Basis of translation for individualised management of health & disease**

**Treatment evolved by "Yukti" (reasonin**

सर्वशरीरचरास्तु वातपित्तश्लेष्माणः सर्वस्मिञ्छरीरं कुपिताकुपिताः शुभाशुभानि कुर्वन्ति—
प्रकृतिभूताः शुभान्युपचयबलवर्णप्रसादादीनि, अशुभानि पुनर्विकृतिमापन्ना विकारसंज्ञकानि ॥ ९ ॥

c.su.20/9

Yukti ( युक्ति)-

मात्राकालाश्रया युक्तिः, सिद्धिर्युक्तौ प्रतिष्ठिता। तिष्ठत्युपरि युक्तिज्ञो द्रव्यज्ञानवतां सदा॥
चरक संहिता सूत्र स्थान २/१६

Therapeutic aptness or rational therapy depends on the matra (dose) and kala(time).
Success of the treatment depends on yukti (rational therapeutics). But prior to the
application of yukti (rational therapeutics) the physician should always possess complete
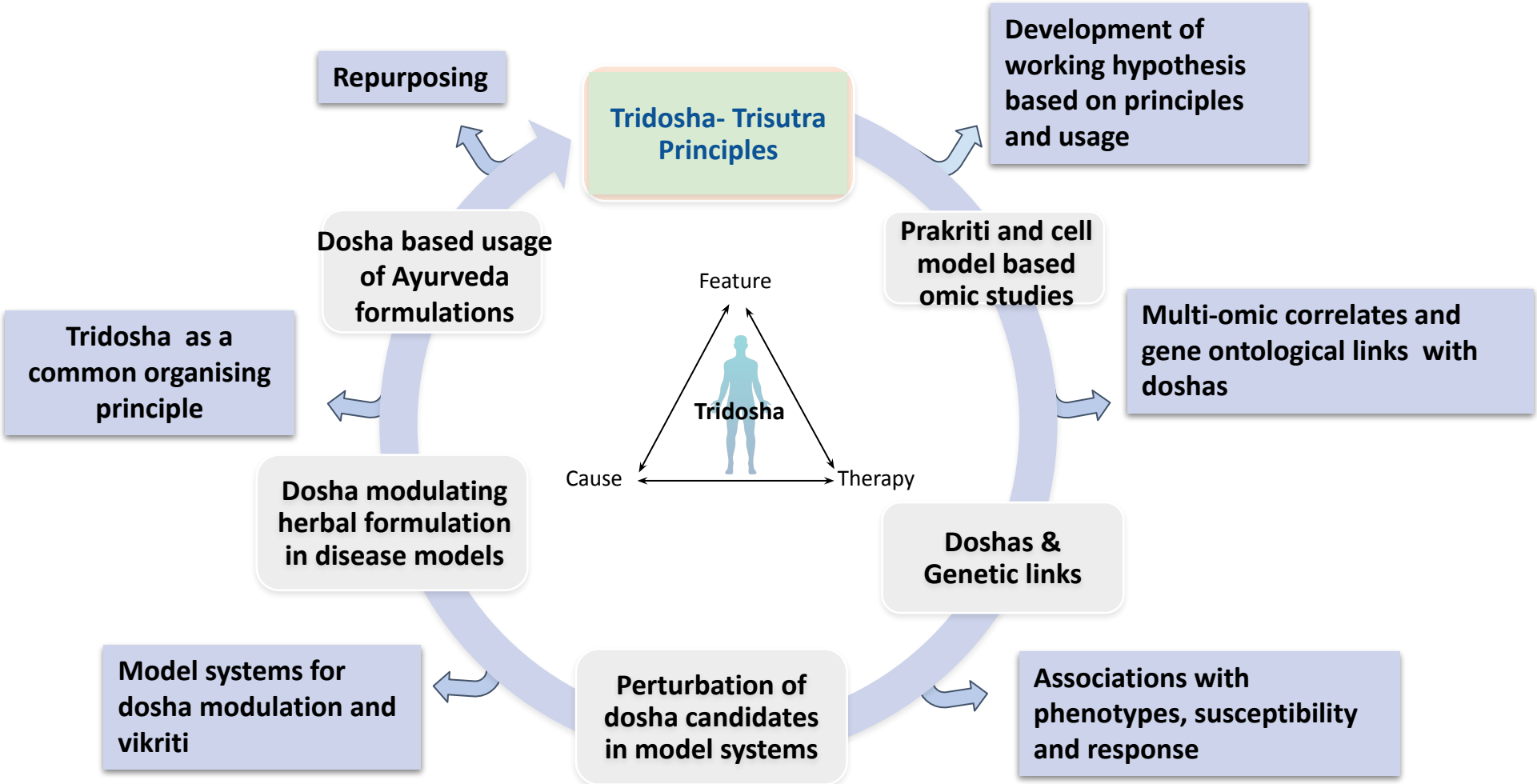knowledge about drugs.

# Operational framework for exploring "trisutra" ayurveda

**Summary**



- Repurposing
- Tridosha- Trisutra Principles
- Development of working hypothesis based on principles and usage
- Dosha based usage of Ayurveda formulations
- Prakriti and cell model based omic studies
- Tridosha as a common organising principle
- Multi-omic correlates and gene ontological links with doshas
- Dosha modulating herbal formulation in disease models
- Doshas & Genetic links
- Model systems for dosha modulation and vikriti
- Perturbation of dosha candidates in model systems
- Associations with phenotypes, susceptibility and response

Feature

Tridosha

Cause — Therapy

# Molecular corelates of *Trisutra* framework : platform for translation

*Differences between constitution types  - Hypoxia response*

# Prakriti, dosha and cellular outcomes

| | |
|---|---|
| Top | Research |
| Abstract | Highly accessed   Open Access |
| Background | Whole genome expression and biochemical correlates of extreme constitutional types defined in Ayurveda |
| Methods | |
| Results | |
| Discussion | |
| Conclusion | |
| Competing interests | |

**Whole genome expression and biochemical correlates of extreme constitutional types defined in Ayurveda**

Bhavana Prasher[1]* ✉, Sapna Negi[1]* ✉, Shilpi Aggarwal[1] ✉, Amit K Mandal[1] ✉, Tav P Sethi[1] ✉, Shailaja R Deshmukh[2] ✉, Sudha G Purohit[2] ✉, Shantanu Sengupta[1] ✉, Sangeeta Khanna[1] ✉, Farhan Mohammad[1] ✉, Gaurav Garg[1] ✉, Samir K Brahmachari[1] ✉, Indian Genome Variation Consortium[1] and Mitali Mukerji[1] ✉

1  Genomics and Molecular Medicine, Functional Genomics Unit, Institute of Genomics and Integrative Biology (CSIR), Mall Road, 110007 Delhi, India
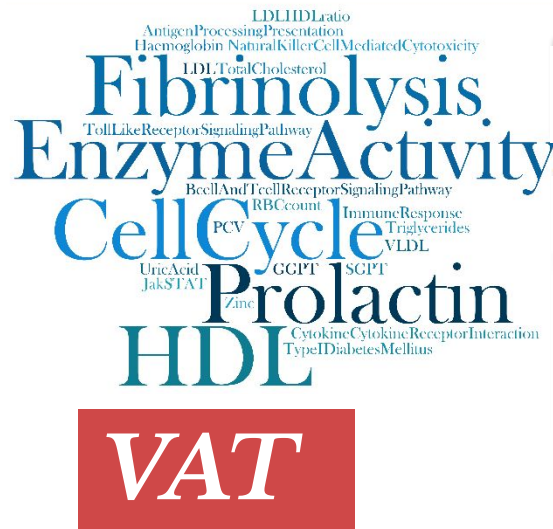2  Department of Statistics, University of Pune, 411007 Pune, India

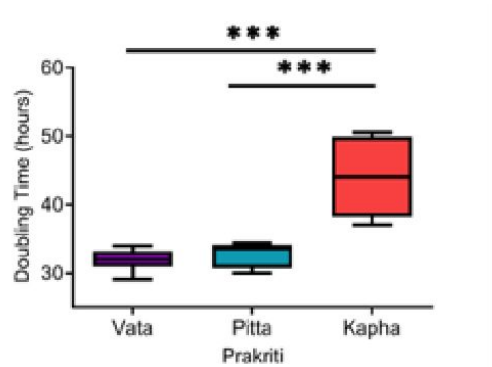✉ author email   ✉ corresponding author email   * Contributed equally

*Vata* regulates cell division and morphogenesis

शरीराख्यास्तु परमाणुभेदेनापरिसंख्येया भवन्ति, अतिबहुत्वादतिसौक्ष्म्यादतीन्द्रियत्वाच । तेषां संयोगविभागे परमाणूनां कारणं वायुः कर्मस्वभावश्च ॥ १७ ॥
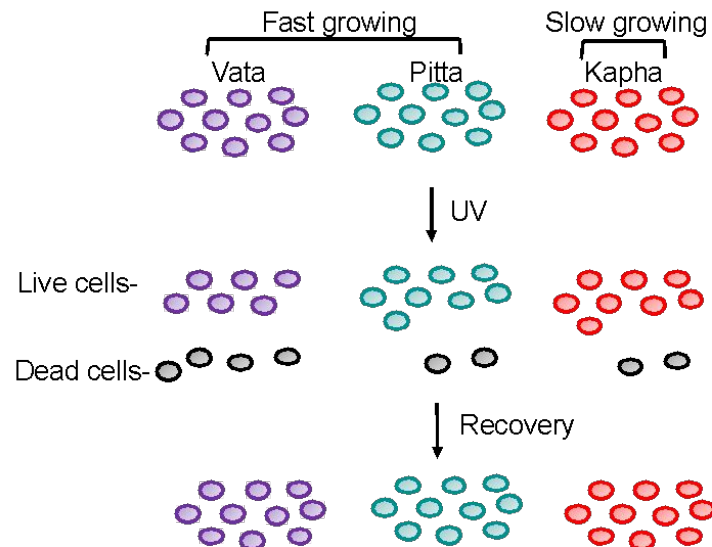
c.sa.7/17

**VAT**   **PITT**   **KAPH**

# Inter-individual variability in cell proliferation rates : Who cares?



N=3 (*Vata* & *Kapha*), N=2 (*Pitta*); n=3, *** = P<0.0001

RESEARCH PAPER

## Baseline cell proliferation rates and response to UV differ in lymphoblastoid cell lines derived from healthy individuals of extreme constitution types

Sumita Chakraborty, Sunanda Singhmar, Dayanidhi Singh, Mahua Maulik, Rutuja Patil, Satyam Kumar Agrawal, Anushree Mishra, Madeeha Ghazi, Archana Vats, Vivek T Natarajan, Sanjay Juvekar, Bhavana Prasher, and Mitali Mukerji

aCentre of Excellence for Applied Development of Ayurveda Prakriti and Genomics, CSIR-Institute of Genomic Delhi, India; bCSIR Ayurgenomics Unit-TRISUTRA, CSIR-Institute of Genomics & Integrative Biology, New Delhi, Molecular Medicine, CSIR-Institute of Genomics & Integrative Biology, New Delhi, India; dAcademy of Scientifi (AcSIR), Ghaziabad, India; eDepartment of Biological Sciences, Indian Institute of Science Education & Researc Nadia, West Bengal, India; fVadu Rural Health Program, KEM Hospital Research Centre, Pune, Maharashtra, Inc Emerging Sciences (SPES), Baddi University of Emerging Science and Technology (BUEST), Baddi, Himachal Pr

SCIENTIFIC REPORTS
natureresearch

Check for updates

## Lithium response in bipolar disorder correlates with improved cell viability of patient derived cell lines

Pradip Paul [1], Shruti Iyer[2], Ravi Kumar Nadella [1], Rashmitha Nayak[1], Anirudh S. Chellappa[1], Sheetal Ambardar[2,3], Reeteka Sud[1], Salil K. Sukumaran[1], Meera Purushottam[1], Sanjeev Jain[1,3], ADBS Consortium (ADBS: The Accelerator program for Discovery in Brain disorders using Stem cells)* & Biju Viswanath [1]

Lithium is an effective, well-established treatment for bipolar disorder (BD). However, the mechanisms of its action, and reasons for variations in clinical response, are unclear. We used neural precursor cells (NPCs) and lymphoblastoid cell lines (LCLs), from BD patients characterized for clinical response to lithium (using the "Alda scale" and "NIMH Retrospective Life chart method"), to interrogate cellular phenotypes related to both disease and clinical lithium response. NPCs from two biologically related BD patients who differed in their clinical response to lithium were compared with healthy controls. RNA-Seq and analysis, mitochondrial membrane potential (MMP), cell viability, and cell proliferation parameters were assessed, with and without *in vitro* lithium. These parameters were also examined in LCLs from 25 BD patients (16 lithium responders and 9 non-responders), and 12 controls. MMP was lower in both NPCs and LCLs from BD; but it was reversed with *in vitro* lithium only in LCLs, and this was unrelated to clinical lithium response. The higher cell proliferation observed in BD was unaffected by *in vitro* lithium. Cell death was greater in BD. However, LCLs from clinical lithium responders could be rescued by addition of *in vitro* lithium. *In vitro* lithium also enhanced *BCL2* and *GSK3B* expression in these cells. Our findings indicate cellular phenotypes related to the disease (MMP, cell proliferation) in both NPCs and LCLs; and those related to clinical lithium response (cell viability, *BCL2/GSK3B* expression) in LCLs.

# Exploring molecular connectivity through Ayurveda based formulations

**Trisutra framework**

**?**

**Cause**
(*hetu*)

mechanism

**Features**
(*lakshana*)

effect

**Therapeutics**
(*aushadha*)
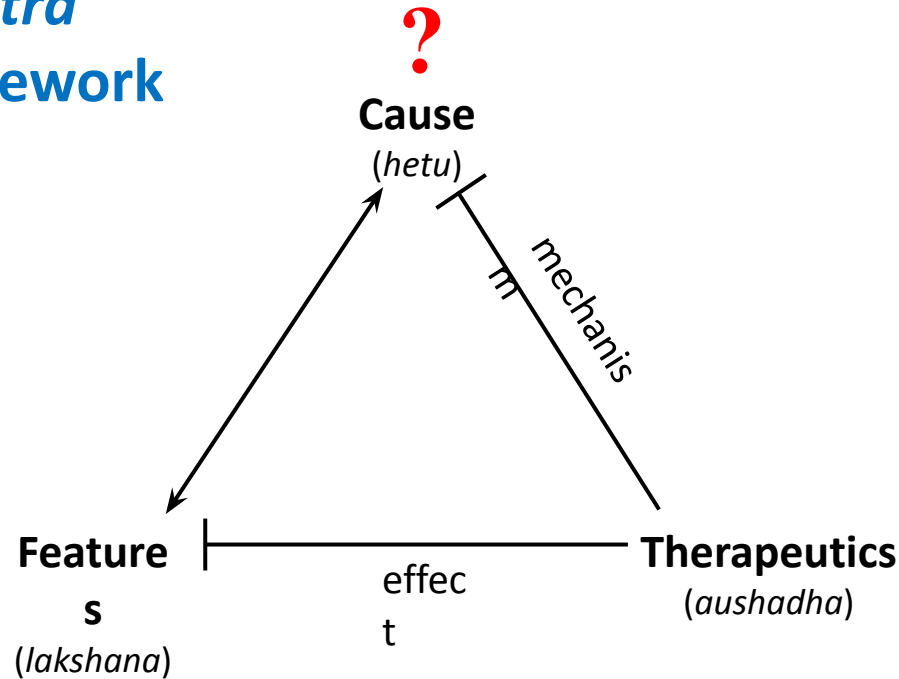
- **Repurposing of Ayurveda formulation in the norm?**
- **Is there a cross-talk between pathways ?**
- **Is there a molecular basis?**
- **Advantage of whole plant extract is being realized**

*Cissampelos pareira*
(Laghu patha)

***Cissampelos pareira***

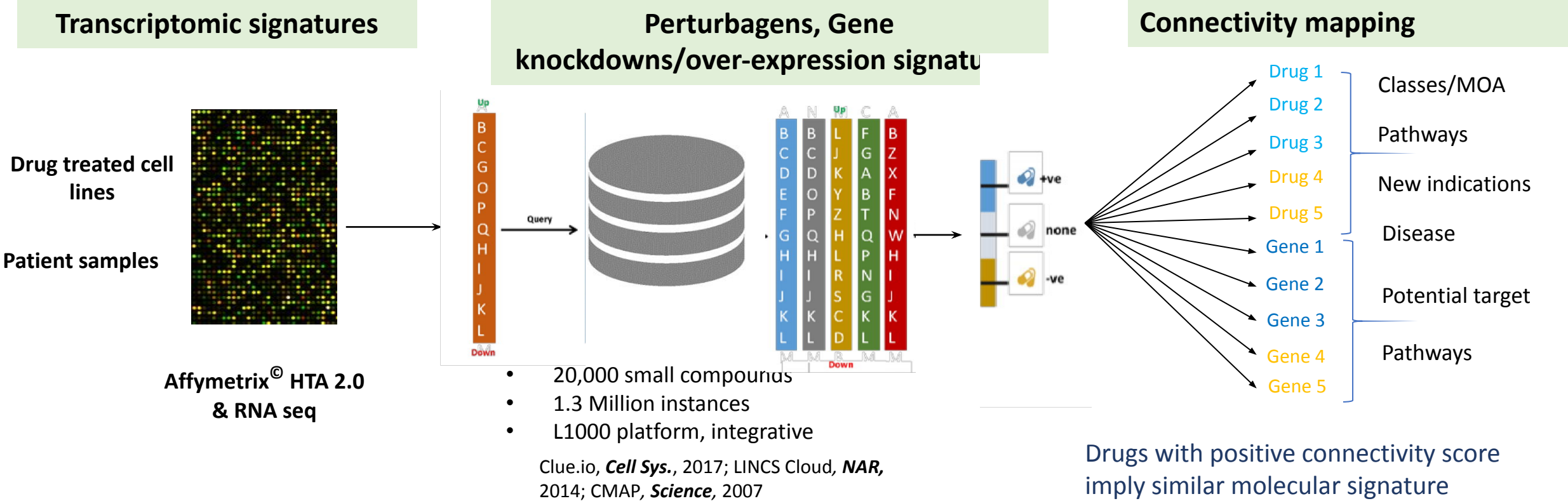**Ayurveda, folk-care and traditional use:**
Against **snake bite**, hormonal disorders, Febrifuge, sepsis, bleeding disorders Fibroid tumours, Poor digestion, Dyspepsia and **malaria etc**

**Estrogen & viral inhibition link???**

# Connectivity Map platform : For understanding/repurposing of Ayurveda formulations



Drugs with positive connectivity score imply similar molecular signature

# Ayurgenomics based framework : Application in exploring poly-pharmacology & repurposing

ESRI

SARS-Cov2
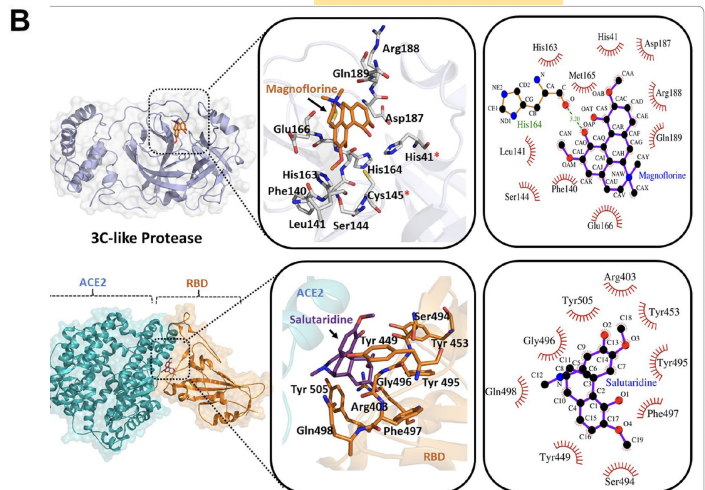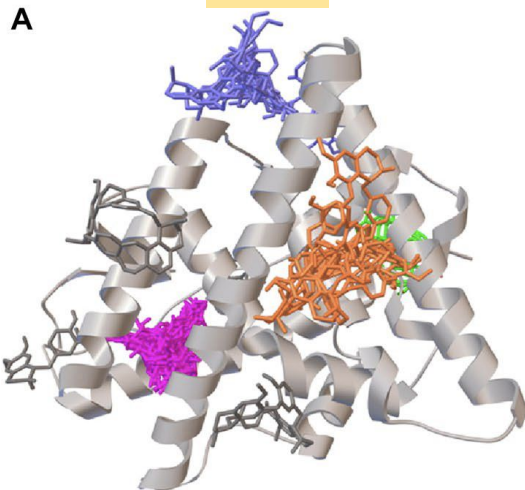


CIPA biomolecules binds ESRI & crucial SARS-CoV2 therapeutic targets
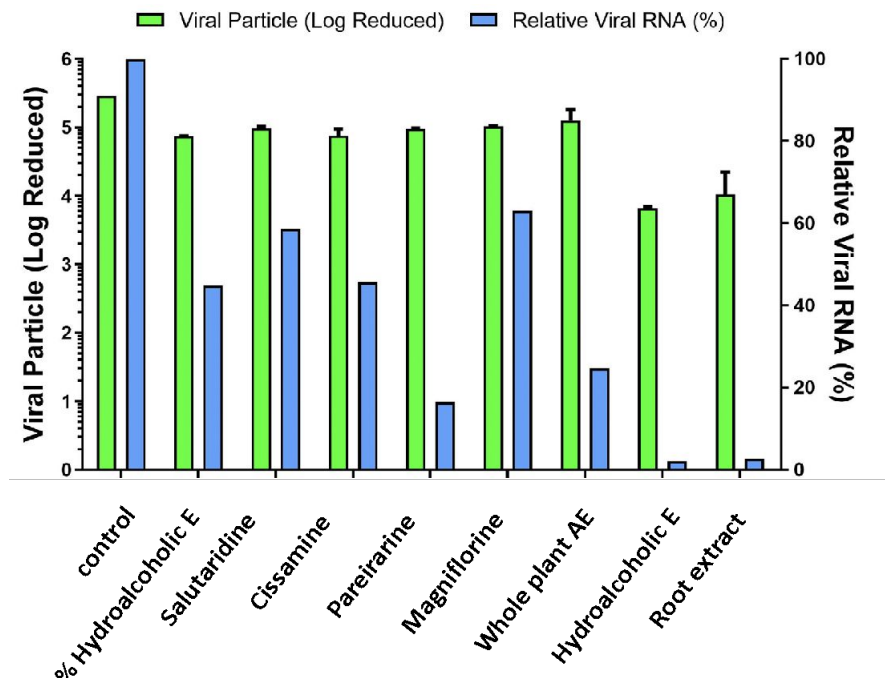
Whole works better than individual molecules

**Traditional use of Cissampelos pareira L. for hormone disorder and fever provides molecular links of ESR1 modulation to viral inhibition**

Madiha Haider, Dhwani Dholakia, Aleksha Panwar, Parth Garg, Vivek Anand, Atish Gheware, Khushboo Singhal, Dayanidhi Singh, Shaunak A Burse, M. Ghalib Enayathullah, Yash Parekh, Sushma Ram, Surekha Kumari, Anmol Kumar, Arjun Ray, Guruprasad R. Medigeshi, Kiran Kumar Bokara, Upendra Sharma, Bhavana Prasher, Mitali Mukerji

This article is a preprint and has not been certified by peer review [what does this mean?].

RESEARCH                                                          Open Access

Anti-SARS-CoV-2 potential of *Cissampelos pareira* L. identified by connectivity map-based analysis and in vitro studies

Madiha Haider[1,2], Vivek Anand[1,2], M. Ghalib Enayathullah[3], Yash Parekh[3], Sushma Ram[3], Surekha Kumari[4,2], Anmol[2,4], Gayatri Panda[5], Manjari Shukla[6], Dhwani Dholakia[1,2], Arjun Ray[5], Sudipta Bhattacharyya[6], Upendra Sharma[2,4], Kiran Kumar Bokara[3], Bhavana Prasher[1,2,7*] and Mitali Mukerji[1,2,6,7*]

# Non-invasive phenotyping for Risk stratification : insights from exome

## Whole Exome Sequencing in Healthy Individuals of Extreme Constitution Types Reveals Differential Disease Risk: A Novel Approach towards Predictive Medicine
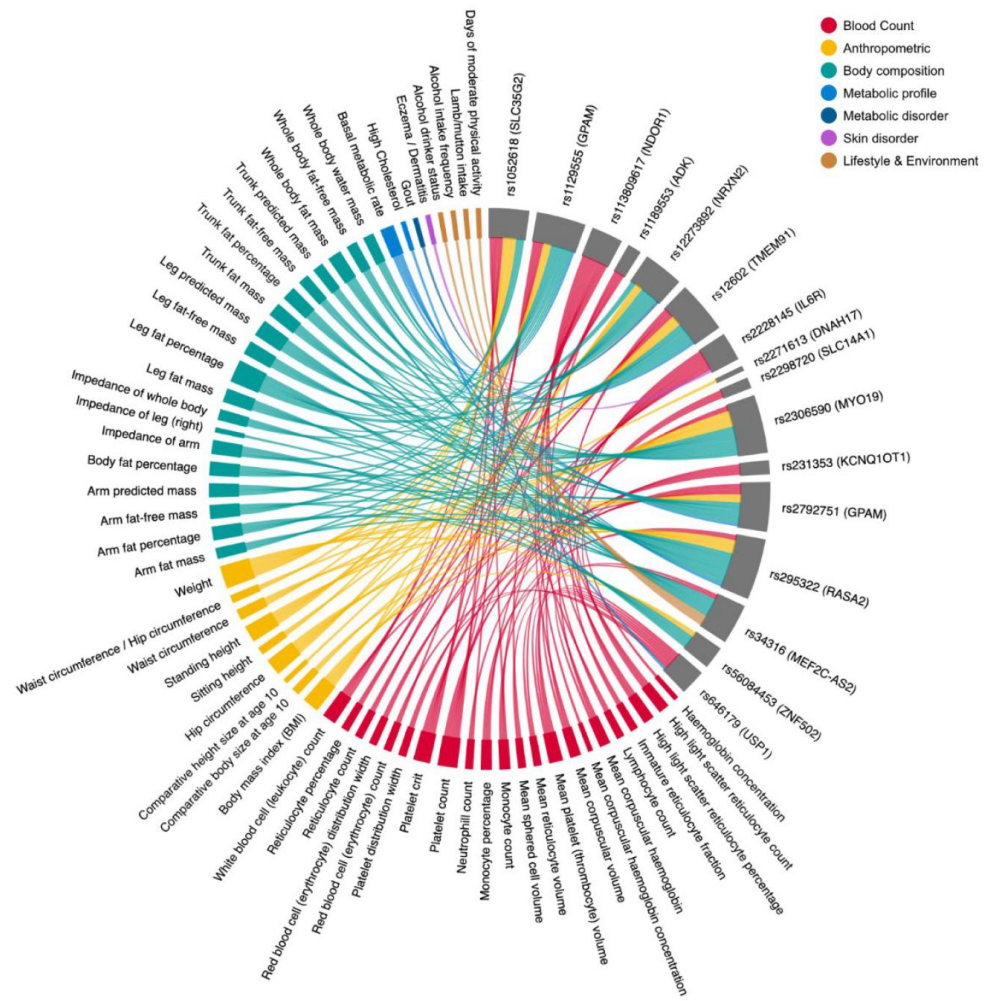


| Gene | dbSNP | alt allele | nature | Variation details | VADU | | North | | profile |
|------|-------|-----------|--------|---|------|------|------|------|---------|
| | | | | | Vata | Kapha | Vata | Kapha | |
| ANKLE1 | rs8100241 | A | missense (A to T) | | 0.611 | 0.333 | 0.6111 | 0.2941 | V vs K |
| | rs8108174 | A | missense (L to Q) | | 0.611 | 0.333 | 0.5833 | 0.2778 | |

## Functional mechanisms underlying pleiotropic risk alleles at the 19p13.1 breast–ovarian cancer susceptibility locus

Kate Lawrenson *et al.*[#]

## ANKLE1 cleaves mitochondrial DNA and contributes to cancer risk by promoting apoptosis resistance and metabolic dysregulation

Piotr Przanowski [1,2✉], Róża K. Przanowska [1,2] & Michael J. Guertin [3,4✉]

# Molecular corelates of doshas through Ayurgenomics

*Mukerji M (2023).*
*Ayurgenomics-based frameworks in precision and integrative medicine: Translational opportunities. Cambridge*

# Ayurgenomics – A framework for bridging Ayurveda with modern medicine
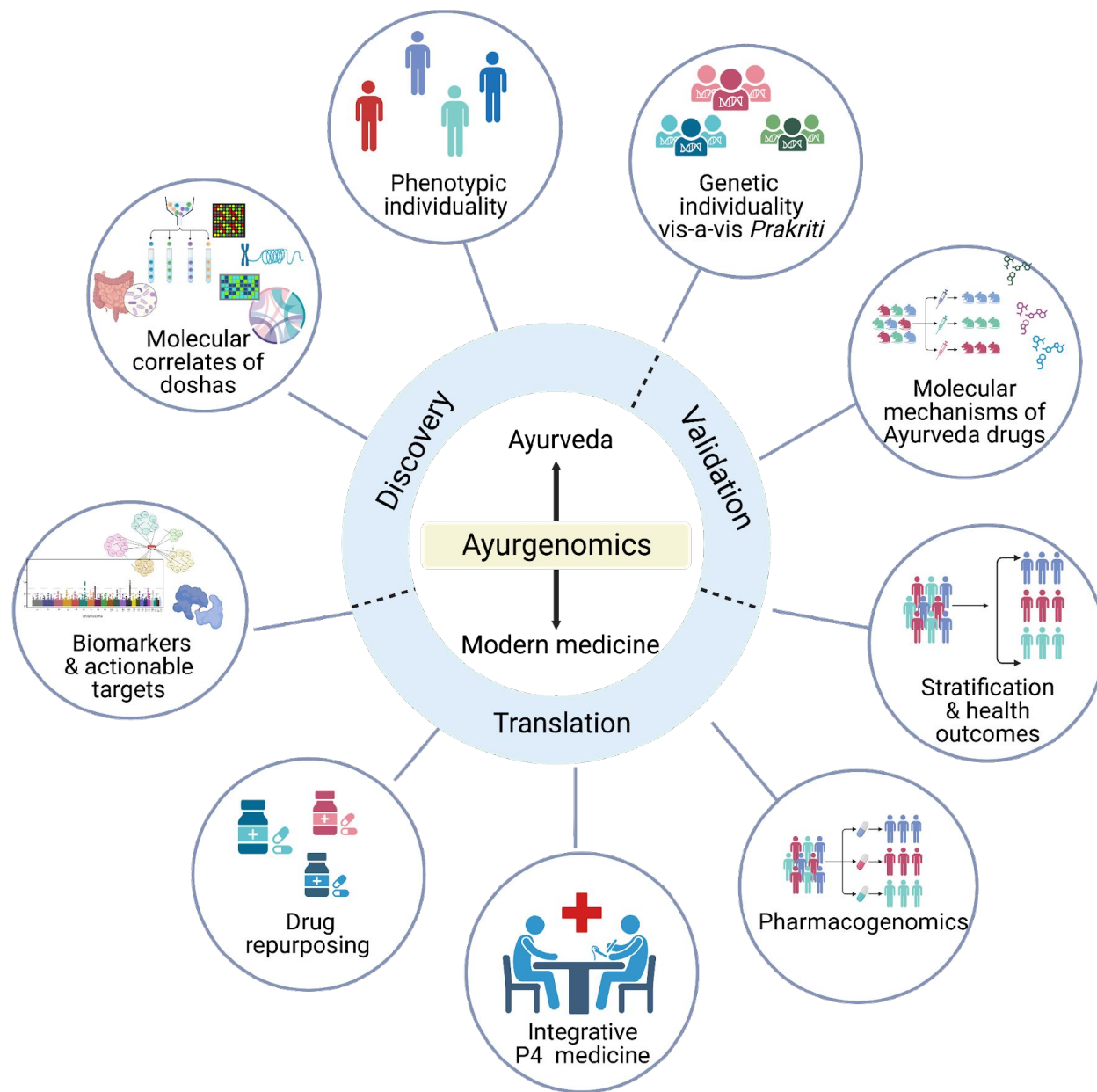
Ayurgenomics-based frameworks in precision and integrative medicine: Translational opportunities

Mitali Mukerji [iD]

Department of Bioscience and Bioengineering, Indian Institute of Technology Jodhpur, Karwar, India and School of Artificial Intelligence and Data Science (AIDE), Indian Institute of Technology Jodhpur, Karwar, India

# Setting up : Trans-disciplinary Centre of Excellence in integrative precision health at IIT Jodhpur

**AYURTECH CoE at IITJ**



**Supported by Ministry of AYUSH**

**First of it's kind unique initiative combining Electronics, Digital health and AI for realizing "Evidence based Ayurveda" solutions**

Learnings Principles-Practice

**+**

Data Sciences

Engineering

Multi- Omics

Translation →

Portability

Shared ontologies

Common query interface

Integration with new data

AI/ML based models

Large –scale applications
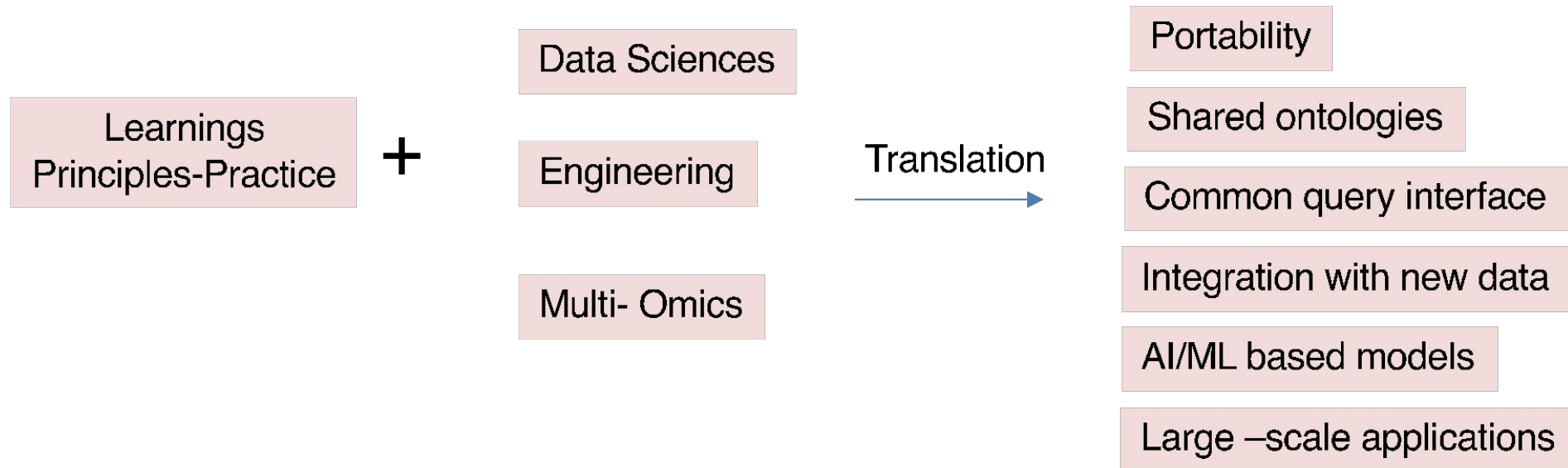
# AYURTECH Aims to Leverage Ayurveda to address GAP areas in current Precision Health Cohorts

- System's understanding through common organizing principle *(tridosha)* and network medicine for translation *(trisutra)*

- Individualized health baseline that inform response and trajectory in geo-spatio-temporal dimensions and pre-emptive management of lifestyle and nutrition

- Disease trajectories based on individual baselines

- Diseases treated in an individual centric manner and as moving targets

- Unique therapeutic modalities
    - Panchkarma
    - Multicomponent single and poly herbo-metallic formulations
    - Different preparations and mode of administrations for diverse therapies
    - Personalised dietary and yoga interventions

- Context of population, culture and habitat on individual baselines

# Development of AyurTech Framework
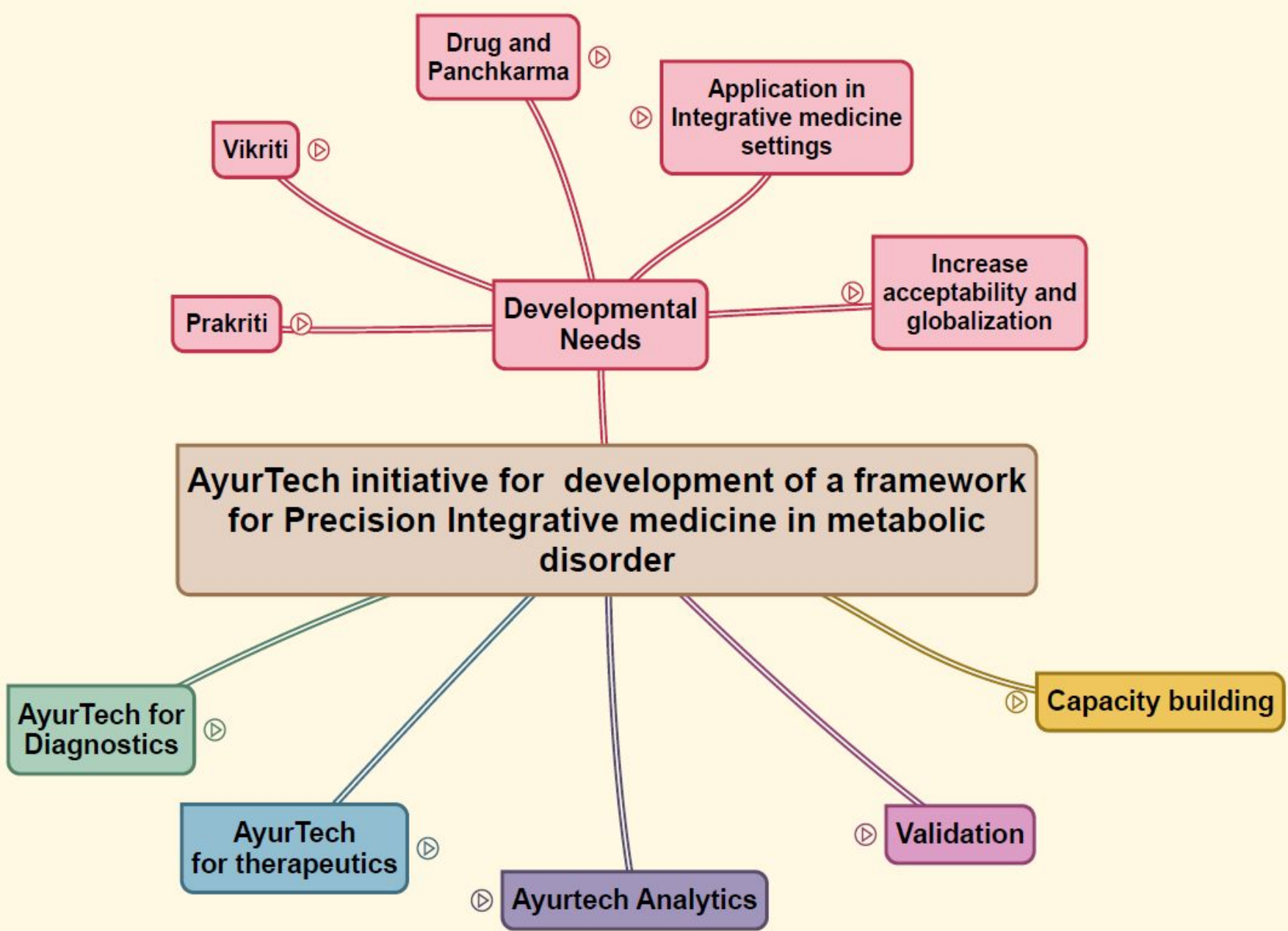


First of it's kind unique initiative combining Electronics, Digital health and AI for realizing "Evidence based Ayurveda" solutions

# Scenario : Patient A –approaches an Ayurveda doctor with a disease called Fanconi anemia

**The patient exhibits the following symptoms**

| HPO_TERM_NAME | CATEGORY |
|---|---|
| Deficient excision of UV-induced pyrimidine | Metabolism/Laboratory abnormality |
| Prolonged G2 phase of cell cycle | Metabolism/Laboratory abnormality |
| Hearing impairment | Ear |
| Strabismus | Eye |
| Short stature | Growth |
| Ectopic kidney | Genitourinary system |
| Male infertility | Genitourinary system |
| Horseshoe kidney | Genitourinary system |
| Duplicated collecting system | Genitourinary system |
| Abnormal renal morphology | Genitourinary system |
| Leukemia | Neoplasm |
| Hypergonadotropic hypogonadism | Endocrine |

| | |
|---|---|
| Abnormality of cardiovascular system morph | Cardiovascular |
| Bruising susceptibility | Skin, Hair, and Nails |
| Abnormal heart morphology | Cardiovascular |
| Complete duplication of thumb phalanx | Skeletal system |
| Intellectual disability | Nervous System |
| Microcephaly | Nervous System |
| Abnormality of skin pigmentation | Skin, Hair, and Nails |
| Chromosomal breakage induced by crosslink | Metabolism/Laboratory abnormality |
| Small for gestational age | Growth |
| Microphthalmia | Eye |
| Autosomal recessive inheritance | Inheritance |
| Absent thumb | Skeletal system |
| Reticulocytopenia | Blood and blood-forming tissues |
| Short thumb | Skeletal system |
| Thrombocytopenia | Blood and blood-forming tissues |
| Cryptorchidism | Genitourinary system |
| Pancytopenia | Blood and blood-forming tissues |
| Absent radius | Skeletal system |
| Renal agenesis | Genitourinary system |
| Anemic pallor | Skin, Hair, and Nails |
| Neutropenia | Blood and blood-forming tissues |

What would be the Ayurveda diagnosis ?

What is the likely cause ??

Which features are informative for diagnosis??

What is the likely therapy ??

## *Vata* regulates cell division and morphogenesis

शरीरावयवास्तु परमाणुभेदेनापरिसंख्येया भवन्ति, अतिबहुत्वादतिसौक्ष्म्यादतीन्द्रियत्वाच्च । तेषां संयोगविभागे परमाणूनां कारणं वायुः कर्मस्वभावश्च ॥ १७ ॥

c.sa.7/17

## Summary

**Gene Location**: 16q24.3

**Definition**

The Fanconi anemia complementation group (FANC) currently includes FANCA, FANCB, FANCC, FANCD1 (also called BRCA2), FANCD2, FANCE, FANCF, FANCG, FANCI, FANCJ (also called BRIP1), FANCL, FANCM and FANCN (also called PALB2). The previously defined group FANCH is the same as FANCA. Fanconi anemia is a genetically heterogeneous recessive disorder characterized by cytogenetic instability, hypersensitivity to DNA crosslinking agents, increased chromosomal breakage, and defective DNA repair. The members of the Fanconi anemia complementation group do not share sequence similarity; they are related by their assembly into a common nuclear protein complex. This gene encodes the protein for complementation group A. Alternative splicing results in multiple transcript variants encoding different isoforms. Mutations in this gene are the most common cause of Fanconi anemia. [provided by RefSeq, Jul 2008]

## No. Descendants

Abnormal cellular physiology

**Abnormality of the cell cycle**

├─ Prolonged G2 phase of
│  cell cycle

# Abnormality of the cell cycle HP:0011018

*An abnormality of the cell cycle.*

**Synonyms:** *Abnormality of the cell cycle*

**Cross References:** *UMLS:C4023594*

⬇ Export Associations

---

| Disease Associations | Gene Associations |
| --- | --- |

| Disease Id | Disease Name | Associated Genes |
| --- | --- | --- |
| OMIM:227650 | Fanconi anemia | FANCA [2175 ] |
| OMIM:227645 | Fanconi anemia, complementation group C | FANCC [2176 ] |
| OMIM:227646 | Fanconi anemia, complementation group D2 | FANCD2 [2177 ] |
| OMIM:600901 | Fanconi anemia, complementation group E | FANCE [2178 ] |

Displaying 4 out of 4.

# Building conversational language between Ayurveda and Modern medicine

*Bridging the ontological gap*

**~10000 HPOs have been annotated by a team of Ayurveda physicians**

| |
|---|
| Glanzmann Thrombasthenia |
| Bleeding Disorder, Platelet-type, 24, Autosomal Dominant |
| Bernard-soulier Syndrome |
| Glycogen Storage Disease Due To Glucose-6-phosphatase Deficiency Type Ib |
| Gray Platelet Syndrome |
| Severe Hemophilia A |
| Thrombocytopenia, Autosomal Dominant, 7 |
| Von Willebrand Disease, Type 1 |
| Von Willebrand Disease, Type 3 |

**Nine syndromes**

**300 features annotation**
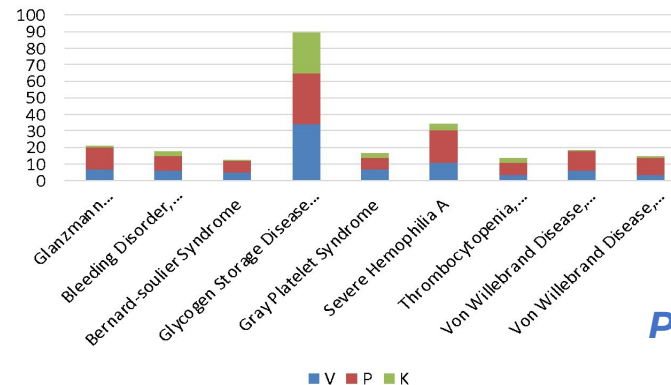
पित्तं विदग्धं स्वगुणैर्विदहत्याशु शोणितम् ।
ततः प्रवर्तते रक्तमूर्ध्वं चाधो द्विधाऽपिवा ॥
उर्ध्वं नासाक्षिकर्णास्ये मेढ्योनि गुदैरधः ।
कुपितं रोमकूपैश्च समस्तैस्तत्प्रवर्तते ॥
-(सु.उ.45)

*Raktapitta*

*Pitta* **predominance in all syndromes**

# AYURTECH Investigators

**Prof. Santanu Chaudhury:** Director IITJ & Dept of Elcetrical Engineering Engineering IIT Delhi
Computer Vision, AI/ML, Big Data Science

**Lead Coordinators**:

**Prof. Mitali Mukerji**: Department Bioscience and Bio Engineering, IIT Jodhpur; Human genomics, personalized medicine, Ayurgenomics

**Prof. Ajay Agarwal**: Department of Electrical engineering; Microelectronics professional, Nanotechnologies, MEMS, microfluidics & Micro-sensors

**BioScience and Bioengineering:**
**Dr. Sudipta Bhattacharyya** Structure-guided rational drug discovery, drug-protein interactions, biophysics, drug screening, & bioassay development
**Dr. Raviraj Vankayala:** nanotheranostics, biophotonics, and drug delivery

**Computer Science & Engineering:**
**Dr. Dip Sankar Banerjee** : high performance computing, data analytics, parallel computing and computer architecture.
**Dr. Sumit Kalra** : Software Architecture, Data Analytics, IoT and Smart Healthcare

**Electrical Engineering:**
**Dr. Rajendra Nagar:** Computer Vision, Computer Graphics, 3D Geometry Processing, and Machine Learning.
**Prof. Manoj Choudhary**: Communications and computing, Wireless Communications & Networks (5G/6G/Next gen WLAN/UWB), AI, IOT, Connected and digital healthcare, Sensors, regulatory & standards frameworks, IPR management.

**Chemistry:**
Dr. Rohan Erande: synthetic organic chemistry, method development and total synthesis of bioactive natural products.

**Industry partners**
**Dr. Bala Pesala:** Professor of Practice, IIT Jodhpur and founder and CEO of Ayur.AI & CTO, Adiuvo Diagnostics and also.
Next gen deep tech companies in the digital health and diagnostics, AI/ML
**Dr. Lipika Dey:** TCS Research and Innovation and heads analytics and insights practices. NLP, text and data mining, information fusion, machine learning, and semantic search.

# AYURTECH Lead Clinical Collaborators for framework development

**Dr. S. R. Rajasthan Ayurved University**
**Nodal co-ordinator:** Vice Chancellor,
**Prof. Abhimanyu Kumar**
**Dr. Sanjay Srivastava:** Shalya Tantra,
**Dr. Prem Prakash Vyas:** Bal Roga
**Dr. Rakesh Kumar Sharma**: Rachana Shareer

| S.No. | Group Name | Name of Faculty Member |
|-------|-----------|------------------------|
| 1. | Prakriti | 1. Dr. Rakesh Kumar Sharma |
| | | 2. Dr. Vinod Kumar Gautam |
| | | 3. Dr. Brahmanand Sharma |
| | | 4. Dr. Dinesh Chandra Sharma |
| 2. | AYURTECH | 1. Dr. Govind Prasad Gupta |
| | | 2. Dr. Gyan Prakash Sharma |
| | | 3. Dr. Sanjay Srivastav |
| | | 4. Dr. Ritu Kapoor |
| | | 5. Dr. Manisha Goel |
| 3. | DESSERT Medicine | 1. Dr. Prem Prakash Vyas |
| | | 2. Dr. Chandan Singh |
| | | 3. Dr. Manoj Adlakha |

**Validation studies for integrative medicine: AYUSH Centre, AIIMS Jodhpur**

**Nodal Coordinator : Director AIIMS Jodhpur**
**Dr Pankaj Bharadwaj :** Additional Professor, Community Medicine & Family Medicine. Coordinator, School of Public Health. **AIIMS Jodhpur**.
**Dr Meenakshi Sharma**

**Implementation studies: More partners have shown Expression of interest from different centres and hospitals………..**

# Ayurgenomics inter-disciplinary team

Dr. Bhavana Prasher MD Ayurveda
Principal Scientist TRISUTRA @IGIB & Co-PI

Prof Samir Brahmachari
(mentor & vision)

## Ayurveda
Shilpi Aggarwal (PhD, BAMS)
Bharat Krishna Khuntia (MD),
Arvind Kumar (MD)

## Genome informatics
Dr Ankita Narang
Dr Pradeep Tiwari
Rintu Kutum (PhD)
Dhwani Dholakia (PhD)
Tahseen Abbas (PhD)

## Modern medicine, Pharma and Physiology
Tav Pritesh Sethi (PhD MBBS)
Dr Atish Gheware (PhD Mpharm)
Ritu Rani (PhD)

## Genomics
Dr Sapna Negi
Dr Binuja Varma,
Dr Rajesh Pandey,
Dr Pankaj Jha
Dr Pramod Gautam
Madiha Haider (PhD)
Gaura Chaturvedi (PhD)
Dayanidhi Singh (PhD)
Sumita Chakravorty (PhD)
Sunanda (PhD)

## Collaborators
Dr. Anurag Agrawal (IGIB),
Dr. Qadar Pasha (IGIB),
Dr. Debasis Dash,
Dr Saurav Ghosh (ISI Kolkata),
Dr Nar Singh Chauhan, MDU, Rohtak
Greg Gibson (Georgia Tech)
Dr Kiran Bokara CSIR-CCMB
Dr Upendra Sharma CSIR-IHBT,
Dr Guruprasad Medigeshi THSTI,
Dr Arjun Ray – IIITD

**Indian Genome Variation Consortium**
**TRISUTRA Ayurgenomics Consortium**
**CSIR-TRISUTRA Team @IGIB**

**KEMHRC**:
Sanjay Juvekar,
Bhushan Girase, Ankita
Shrivastava, Rutuja
Patil,
Dheeraj Aggarwal,
Bharat Choudhury

**DST , CSIR, AYUSH for financial support**

**Public health**

**Modern medicine**

**Ayurveda**

Thank You