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SCIENCE AND SOCIETY FOR SUSTAINABLE FUTURE

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Science and Society for Sustainable Future

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Preface

We are delighted to present this edited volume of **twenty-six** selected chapters from the One-Day National Conference **Science & Society for Sustainable Future (SSSF-2025)**, hosted by the Department of Science, Government First Grade College, Tumkur, in association with the **Karnataka Science & Technology Academy (KSTA), Department of Science & Technology, Government of Karnataka**. The contributions reflect a shared commitment to ensuring that rigorous, ethical, and inclusive science advances tangible societal outcomes across education, health, environment, energy, economy, governance, and culture.

The chapters span physical and life sciences; green chemistry and environmental studies; mathematics, biomathematics, statistics and computing; engineering and technology; nursing and medical sciences; commerce, management and ESG; humanities, social sciences and education; media and communication; library and information science; and physical education and well-being. Several papers also showcase interdisciplinary methods, community-linked case studies, and underscoring the conference vision of science translated for local relevance and global significance.

Our editorial approach emphasized clarity, integrity, and reproducibility. Authors were encouraged to present concise problem statements, methods, results, and limitations; to adhere to ethical norms on similarity, permissions, human/animal approvals where applicable; and to disclose any use of AI assistance transparently. Where feasible, contributors provided pointers to datasets, code, protocols, or justified availability statements to enable verification and reuse. Each chapter underwent screening and review for technical soundness, relevance to the theme, and the potential to inform practice and policy.

We gratefully acknowledge KSTA for its sustained support to Karnataka's science ecosystem; our International and National Advisory Boards, reviewers, session chairs, and the Organising Committee for their meticulous efforts; and our student volunteers for tireless on-ground coordination. Above all, we thank the authors for trusting this platform and contributing work that is both methodologically robust and socially meaningful.

We hope this book serves **researchers, teachers, students, practitioners, and policy actors** as a compact guide to emerging ideas and collaborations-sparking classroom innovations, field pilots, and partnerships that carry science confidently into society and toward a sustainable future.

Editor-in-Chief — **Dr. Yogeesh N**
Editors — **K. C. Jagadeesha**, **Dr. Aisha Siddekha**
Government First Grade College, Tumkur, Karnataka, India

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Science and Society for a Sustainable Future: A Keynote Synthesis

Prof. Rajasab A. H

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(This chapter synthesizes the inaugural and keynote address delivered by Prof. A. H. Rajasab at SSSF-2025. It is prepared for the Edited Volume of the conference and formatted as a narrative chapter for broad, multi-disciplinary readership.)

Abstract

This chapter distils key ideas from the SSSF-2025 inaugural keynote on how frontier science translates into public good. It highlights gene editing as a platform technology for human health and climate-resilient agriculture; developments in quantum science and precision measurement; responsible, judicious adoption of artificial intelligence; foundational case studies from the history of science (from Jenner's vaccination to penicillin, velcro and saccharin) that show the role of the "prepared mind" and serendipity; the relevance of the Sustainable Development Goals (SDGs) and green stewardship; and the need to mainstream microbiology and genomics in curricula. The chapter links each idea to actionable recommendations for research, education, policy, and ethical practice in Karnataka and beyond.

Keywords: CRISPR gene editing, quantum technology, gravitational waves, AI ethics, genomics, microbiome, SDGs, green stewardship, science education

1. Context and Purpose

The SSSF-2025 theme-**Science and Society for Sustainable Future**-asks how rigorous science can be taught, translated, and governed so that it measurably improves health, food systems, water, energy, learning, and livelihoods. The keynote addressed four cross-cutting levers: (i) **platform technologies** that create many solutions (gene editing, quantum, AI), (ii) **prepared minds** and **open institutions** that convert chance into discovery, (iii) **ethics and transparency** as foundations of trust, and (iv) **curriculum reforms** that produce scientifically literate, socially sensitive graduates.

2. Gene Editing as "Molecular Scissors"

***Concept*:** CRISPR-based systems act like **molecular scissors** that cut DNA at specific locations; the cell's repair machinery then introduces, deletes, or replaces sequences. Variants (base editors, prime editors) increase precision and reduce off-target edits.

- **Human health:** prospects for monogenic disorders (e.g., sickle-cell disease), oncology adjuncts, and rare disease programs; the long-term imperative is safety, efficacy, affordability, and access.
- **Agriculture:** higher yields; disease-resistant, climate-tolerant, nutrient-dense varieties; reduction in chemical inputs; faster breeding cycles.
- **Biodiversity & environment:** gene drive research is to be handled with stringent ecological risk appraisal and public engagement.

Table 1. Illustrative use-cases of gene editing

Domain	Example objective	Readiness cues
Hematology	Correct pathogenic variants in β-globin pathway	Clinical protocols, equitable access frameworks
Virology/Oncology	Edit host factors or immune modulation	Safety, longitudinal surveillance
Cereals & Pulses	Disease resistance, drought tolerance	Field trials + farmer advisory & seed systems
Horticulture	Shelf-life, nutrient density	Post-harvest pilots, consumer labeling

Ethics & governance. Guardrails include **informed consent**, long-term follow-up, off-target monitoring, and **transparent benefit-sharing**; **germline editing** remains out of bounds in many jurisdictions.

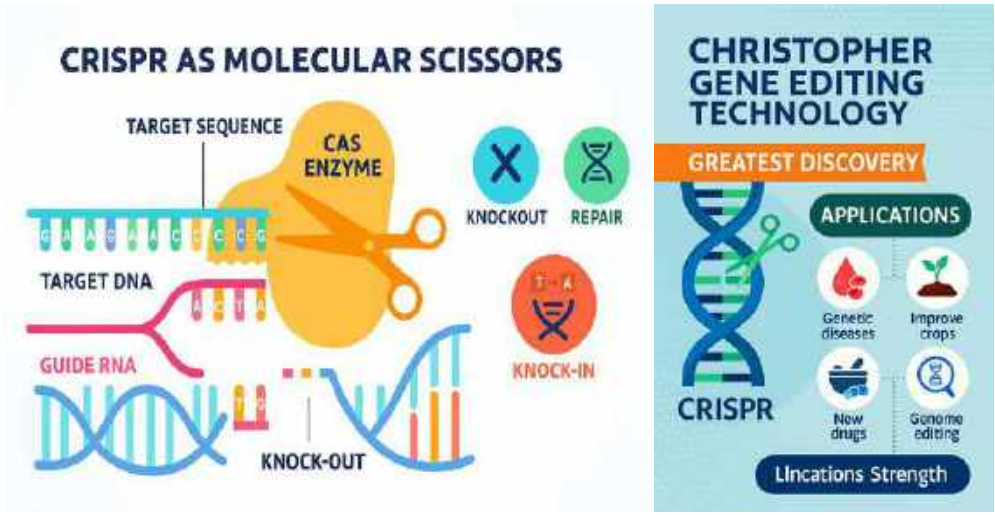

Figure 1 (conceptual): "CRISPR as Molecular Scissors"-target sequence, guide RNA, Cas enzyme, repair outcomes (knock-out/knock-in).

3. Quantum Science, Precision Measurement, and Prepared Ecosystems

The address drew attention to quantum advances-entanglement, sensing, communication, and computation-and to precision measurement achievements such as gravitational-wave detection. In Karnataka, the ecosystem spans premier labs and emerging hubs; site visits and reviews noted instruments and teams growing in Bengaluru and Dharwad.

From demo to utility:

- **Sensing/Metrology:** quantum magnetometers, gravimeters, and clocks can strengthen geodesy, mineral exploration, and navigation.
- **Communication:** quantum key distribution for high-value links.
- **Computing:** near-term hybrid workflows (classical + quantum) for optimization and materials.

4. Physics, Metaphysics, and Meaning

Physics studies material phenomena; yet at quantum scales our intuitions about locality and determinism falter, inviting philosophical reflection without abandoning empiricism. The point is pedagogical: train students to handle uncertainty and models' limits while staying loyal to evidence.

5. Artificial Intelligence: Use with Judgment

AI-chat systems, vision, robotics, data pipelines-has moved from labs to living rooms. The keynote cautioned against over-reliance ("making brilliant students average") and urged judicious use.

Good practices for campuses and labs

(i) **Declare AI assistance** in manuscripts and theses; keep raw data and prompts as appendices/logs.
(ii) **Design assessments** that test original thought (viva, whiteboard, oral defenses, replication tasks).
(iii) **Protect privacy:** minimum data, consent, secure storage, model choice.
(iv) **Uphold academic integrity:** similarity checks + manual review; teach **critical thinking** explicitly.

6. Human Genome Mapping

Modern genomics resolves chromosome-wise gene content, regulatory elements, and population variation. For public systems, priorities are rare disease diagnostics, pharmacogenomics in essential drugs, and education so clinicians and teachers can interpret results responsibly.

7. Black Holes and Twenty-First Century Astrophysics

Observations-from stellar dynamics to imaging of event-horizon-scale shadows and gravitational-wave signals-have transformed black holes from theory to measured reality, expanding STEM interest and data-driven astronomy education.

8. mRNA Platforms and Public Health

The pandemic accelerated mRNA and other platform vaccine technologies. India's ecosystem-public labs, start-ups, and manufacturers-demonstrated rapid development and scale-up. The lesson: platform thinking + regulatory preparedness shortens time from lab to clinic.

9. A Prepared Mind: Graphene, Newton, Jenner and Beyond

The keynote offered vivid reminders that breakthroughs often mix discipline with chance.

- ***Graphene*:** a one-atom-thick honeycomb lattice-ultra-light, strong, and conductive-opened new physics and devices.
- ***Newton's gravity*:** a prepared mind turns an ordinary event into universal law.

- ***Jenner's vaccination*:** methodical observation and trial led to a public-health revolution.

Table 2. Serendipity with method-classic cases

Discovery	Trigger	Prepared action	Lasting impact
Jenner's vaccine	Cowpox observation	Controlled inoculation & follow-up	Immunization paradigm
Penicillin	Mold contamination	Isolation & testing	Antibiotic era
Velcro	Burrs on fabric	Microscopy → hook-loop design	Materials design
Saccharin	Lab accident	Verification → synthesis	Artificial sweeteners
Botox (therapeutic)	Toxin biology	Dose control, trials	Neuro-therapeutics & aesthetics

10. Evolution and the Nature of Matter

Evolutionary thinking applies from **molecules to ecosystems**. Conservation principles in chemistry-"neither created nor destroyed" within reactions-help students grasp **transformations** instead of teleology. Philosophical parallels in earlier traditions can be discussed **without** diluting scientific standards.

11. SDGs, Green Stewardship, and Civic Science

The 17 SDGs are a **dashboard** for institutions. The keynote urged every public office and campus to **display** SDGs and map courses/projects to them.

Green revolution-reframed: Respect soils, water tables, and biodiversity; invest in precision agriculture, agro-meteorology, and bio-inputs; measure outcomes (yield *and* ecosystem health).

12. Microbes in Human Welfare-Put It in the Syllabus

From fermentation and soil health to human microbiome and bioremediation, microbes are central. The recommendation is clear: core microbiology with labs, local case studies, and bio-safety/ethics modules should be mandatory across life-science tracks, with electives for engineers and managers.

13. Recommendations (Education–Research–Policy)

Education

- Integrate biomathematics (modelling, statistics, coding) across UG/PG; add modules on AI literacy and data ethics.

- Bilingual science communication (Kannada/English) for inclusion.

Research

- Platform programs in gene editing, quantum sensing, vaccines/diagnostics, and agro-innovation with safety and ethics embedded.
- Shared facilities in Bengaluru–Dharwad corridors; open protocols and reproducibility checklists.

Policy & Outreach

- SDG-aligned campus compacts; publish annual metrics (water, energy, emissions, waste, diversity).
- Citizen-science pilots (air, water, biodiversity) with local bodies; curated YouTube/Meet channels for open talks.

14. Concluding Note

The keynote's central message is practical and hopeful: **platform science + prepared minds + ethical governance = public good**. If Karnataka's institutions teach with clarity, research with rigor, share with openness, and act with empathy, then science can travel-**from paper to people**-and help deliver a sustainable, equitable future.

Vasantha T D, Yogeesh N, K C Jagadeesha, and Aisha Siddekha Editors

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The submissions gathered here span physical and life sciences; green chemistry and environmental studies; mathematics, biomathematics, statistics and computing; engineering and technology; nursing and medical sciences; commerce, management and ESG; humanities, social sciences and education; media and communication; library and information science; physical education and well-being; and a dedicated stream in Kannada aligned to science and sustainability. It is purposeful because sustainability futures requires transdisciplinary, believable, reproducible analysis, and understandable communications with the wider audience.

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