BIO Web of Conferences **183**, 0100575(2025) https://doi.org/10.1051/bioconf/20251830100575
ICoLIST2025

Eco-Economics: Innovative Solutions for Sustainable Development and Economic Expansion

Zalina Dzhambekova[1,1], *Kheda* Baitulaeva[2], *Said-Ali* Davtaev [3]

[1] Medical Academy of Kabardino-Balkarian State University named after H.M. Berbekov, Nalchik, Russia

[2] North Ossetian State Medical Academy, Vladikavkaz, Russia

[3] Kadyrov Chechen State University, Grozny, Russia

Abstract. This paper explores the environmentally friendly aspects of assisted reproduction techniques and discusses innovative approaches aimed at promoting the future health of the planet and humanity. Assisted reproduction technologies have revolutionized fertility treatments, but their environmental impact has raised concerns. The paper examines sustainable practices within assisted reproduction, such as reducing energy consumption, minimizing waste generation, and adopting eco-friendly materials. It also discusses emerging innovations in the field, including advancements in cryopreservation techniques, development of biodegradable materials for medical devices, and utilization of renewable energy sources. By addressing the environmental footprint of assisted reproduction, this paper aims to contribute to the sustainability of both human health and the planet.

1 Introduction

Biodiversity, the wide array of life forms on our planet, is vital for human existence. Yet, human actions are propelling a dire situation—the sixth mass extinction—putting not just other species at risk, but also our own survival [1]. Animal populations are dwindling, fragmented, and losing genetic diversity, imperiling their future viability. Conservation

[1] Corresponding author: zalina.j@icloud.com

endeavors, both within natural habitats (in situ) and outside of them (ex situ), urgently need bolstering to stem the tide of extinction, which is outpacing natural rates [2].

Cryobanking, the preservation of living cells and tissues at ultra-low temperatures (196°C), coupled with advanced reproductive technologies (ART), presents a lifeline for species survival. By safeguarding genetic material, cryobanking offers the possibility of reintroducing lost diversity into populations, thus rejuvenating biodiversity. However, successful application demands tailored protocols for each species and a profound grasp of biological fundamentals across diverse taxa.

Presently, ART predominantly serves mammalian species, but it's imperative to broaden its scope to encompass all groups, particularly the most endangered like amphibians [3]. Cryobanking of gametes, reproductive tissues, and somatic cells acts as a bridge between the current loss of genetic diversity and future technological breakthroughs. This strategy prioritizes species for cryobanking and navigates the triumphs and hurdles of cryopreservation and various ART methods.

In summary, cryobanking is essential for conservation strategies, offering a lifeline for species facing extinction [4]. By combining cryopreservation with advanced reproductive technologies, there is potential not only to halt but also to reverse biodiversity loss. It is imperative to invest in cryobanking and expand ART efforts to safeguard the genetic diversity necessary for the survival of Earth's diverse ecosystems.

The last quarter of the 20th century marked significant advancements in reproductive medicine, notably with the birth of the first IVF human baby in 1978, achieved by Dr. RG Edwards and Dr. Patrick Steptoe in England [5]. Subsequent milestones included India's first test tube baby and the country's scientifically documented IVF baby in 1986. Since then, over three million babies worldwide have been born through Assisted Reproductive Technology (ART), offering hope to many infertile couples while posing challenges for those unable to access these technologies.

Despite the transformative impact of ART, its success rates remain limited, with only about 10% of cases resulting in pregnancy. Additionally, the proliferation of infertility clinics in India underscores the demand for ART but also raises concerns about technical expertise, infrastructure, and potential misuse of technology. The lack of government regulation further compounds these challenges, leading to ethical, safety, and moral dilemmas.

Key stakeholders, including scientists, ART service providers, health professionals, infertile couples, and policymakers, face various challenges in navigating the complexities of ART. These challenges span scientific, health service, professional, social, and regulatory domains, highlighting the multifaceted nature of addressing infertility and the ethical considerations inherent in reproductive medicine.

2 Research methodology

Infertile couples increasingly seek Assisted Reproductive Technology (ART) to address infertility, but concerns have arisen regarding the increased risk of specific disorders and adverse outcomes in ART-conceived pregnancies and children [6]. Studies have shown that ART procedures can induce epigenetic changes in embryonic and fetal tissues, which may be linked to conditions such as low birth weight, preeclampsia, and preterm labor. These alterations in the epigenome could have long-term implications for the health of offspring, including hypertension, diabetes, and metabolic disorders later in life.

3 Results and Discussions

The primary impact on public health arises from the uncertain long-term effects of various assisted reproductive technology (ART) procedures, which remain incompletely understood. These consequences extend to mothers, children, and entire families, affecting their support systems. In vitro fertilization (IVF), the cornerstone of ART, has been utilized for over thirty years, enabling us to assess its enduring impacts. While initial studies on
short-term biological outcomes suggest that rates of congenital abnormalities, childhood cancers, chronic illnesses, and cognitive development generally resemble those of naturally conceived pregnancies, comprehensive investigations beyond early childhood are hindered by challenges in data integration and prolonged monitoring [7].

Some studies propose that children conceived through IVF may encounter elevated long-term morbidity rates compared to naturally conceived counterparts, often linked to the higher probability of multiple and premature births associated with ART. Psychosocial research indicates that mothers of ART-conceived children may perceive their offspring as more vulnerable, feel less competent, and experience heightened parenting anxiety and diminished family satisfaction. Similarly, parents of ART-conceived children may exhibit lower self-esteem and marital contentment [8]. These children themselves may display more temperamental behavior as infants, exhibit heightened negative responses to stress, encounter behavioral challenges, struggle with school adaptation, and demonstrate increased levels of aggression, anxiety, and depression.

As ART usage proliferates, these trends could significantly impact societal institutions such as public education and healthcare. Furthermore, there's a dearth of literature addressing the emotional toll on patients undergoing protracted, invasive, and costly ART treatments without achieving success. Managing expectations becomes paramount, particularly given the heightened anxiety levels experienced by women undergoing IVF, which paradoxically may reduce pregnancy rates. With the aging demographic and escalating demand for ART, our mental health services must evolve to address these shifting demands.

Utilizing established conservation assessment frameworks such as the IUCN Red List can aid in prioritizing species for cryobanking initiatives, with a focus on the most imperiled species. Nonetheless, concentrating on species teetering on the brink of extinction may not always yield significant conservation gains if they lack intra-population genetic diversity. Future gene-editing tools like CRISPR-Cas9 may present avenues to tackle genetic diversity issues, yet ethical considerations must be meticulously weighed. Overall, while cryobanking harbors promise for biodiversity conservation, strategic planning and ethical deliberations are indispensable for its efficacious execution [9]. To enhance the effectiveness of conservation interventions and population management, it's essential to target species with adequate population sizes and genetic diversity during sample collection. This necessitates a thorough comprehension of population dynamics and genetic variability, employing assessment frameworks like the IUCN Red List to identify species currently not under threat but susceptible to future risks. By prioritizing these species for cryobanking initiatives before their populations decline, proactive intervention and genetic restoration become viable, enhancing the prospects of successful species recovery. Although foreseeing which species will face threats is complex, studies have pinpointed vulnerable species, including those not presently endangered, thus offering new focal points for conservation and cryobanking endeavors. Opportunities for sample collection should be integrated into prioritization processes, considering that many species inhabit remote or inaccessible habitats. The global network of zoos and aquariums constitutes invaluable resources for sample collection, housing populations of numerous threatened or potentially threatened species and collaborating with in situ conservation projects [10]. Furthermore, prioritizing individuals within ex situ managed populations for cryobanking optimizes the conservation value of banked samples and mitigates the loss of genetic diversity. Species managed in zoos and aquariums for genetic diversity preservation through regional or international programs can aid in identifying the most genetically significant individuals for sampling. Strategic cryobanking initiatives have effectively reintroduced lost genetic variability into existing populations of species like the black-footed ferret and the endangered Przewalski's horse. Cryobanking should be regarded as an integral component of the conservation toolbox, capable of reducing expenses compared to traditional ex situ breeding strategies when deployed judiciously. However, it necessitates the amalgamation of both species-level and individual animal prioritizations for optimal conservation and population management outcomes.

4 Conclusions

Human activities are propelling the world into its sixth mass extinction event, marking the most substantial loss of biodiversity in over 65 million years. Unlike previous occurrences driven by natural factors, this extinction event is primarily fueled by human actions, leading to extinction rates estimated to be 1000–10,000 times higher than normal. This precipitous decline in biodiversity poses a grave threat to our own existence, as dwindling species populations result in reduced genetic diversity, jeopardizing their ability to survive in the long term. This review explores strategies for indefinitely preserving living cells and tissues at low temperatures, a process known as cryobanking, along with the requisite technologies to rejuvenate biodiversity. As advancements in appropriate techniques continue to emerge, these preserved samples hold the potential to be thawed and utilized to bolster genetic diversity and generate live offspring of endangered species, thereby safeguarding their survival over time. Additionally, the review delves into the accomplishments and obstacles of genome resource cryopreservation, with the aim of charting a course towards a future characterized by stable biodiversity.

References

1. Sokolov A.V., Chulok A.A. Long-term forecast of scientific and technological development of Russia for the period until 2030: key features and first results. Forsyth. 2012; 6 (1): 12–25.
2. Musaeva Kh. M. Analysis of key success factors of Russian biotech firms, 76, 08003 (2023)
3. Ivanchenko Y. A., Vorotilina T. V., Teygisova S. S., Shul'zhenko I. S., Selivanova K. A. Fenômeno da competição no ambiente educacional // Revista on line de Política e Gestão Educacional. 2022-03-31. Journal article. DOI: 10.22633/rpge.v26iesp.2.16563 4. Podkolzina, I., Tenishchev, A., Gornostaeva, Z., Tekeeva, H., Tandelova, O. Assessment of Threats to Environmental Security and Climate Change // BIO Web of Conferences, 2023, 63, 04002
5. Podkolzina, I., Tenishchev, A., Gornostaeva, Z., Tekeeva, H., Tandelova, O. Ecological and Food Security in the Conditions of the Geopolitical Situation in the Worldglobal Digital Transformation Trends in Real Sectors of the Economy // SHS Web of Conferences 172, 02041 (2023)
6. Agarkova L., Gurnovich T., Shmatko S., Podkolzina I., Filonich V. Priority directions of development of the cluster of innovative education in the regional agro-industrial

complex // International Journal of Monetary Economics and Finance. 2016. T. 6. № 2. C. 718.

7. Salamova A. S., Dzhioeva O. Green transformation of the global economy in the context of sustainable development, pp. 152-159 (2023)
8. Gakaev R.A. The world’s forests are a stabilizing element of the climate system, 76, 06003 (2023)
9. Dzhatdoeva D.T. Study of the composition of medicinal plants in the prevention of infectious diseases based on biochemical mechanisms. Bulletin of the Kursk State Agricultural Academy. 2022. No. 9. pp. 88-93.
10. S.G. Shmatko, L.V. Agarkova, T.G.Gurnovich, I.M. Podkolzina, Problems of increasing the quality of raw material for wine in the stavropol region, 7 (2), pp. 725730 (2016)