

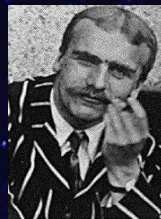
THE USE OF ECTOGENESIS

FOR SPACE EXPLORATION

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What is Ectogenesis?

- Term 'ectogenesis' coined by scientist **JBS Haldane** in a 1923 speech
- **Ectogenesis**: growth of a fetus outside the body in an artificial womb
- **Complete ectogenesis**: growth of a fetus entirely outside the body, from conception to 'birth', in an artificial womb
- **Partial ectogenesis**: the transfer of a fetus at some point during pregnancy from body to develop in an artificial womb



JBS Haldane

Scientific Developments in Ectogenesis

- Advances in **partial ectogenesis** in animals developing at pace
- Most notably, the **EVE Project** (Usuda et al 2020) and **EXTEND** (Partridge et al 2017) which grew premature ovine fetuses *ex vivo*, with hopes to someday translate this technology to human use
- Complete ectogenesis not yet possible – it faces greater challenges, which are both **scientific** (e.g., challenges in growing a fetus entirely *ex vivo* without the human placenta and womb) and **legal** (e.g., the 14-day rule in embryo research which prohibits the growth of embryos *ex vivo* beyond 14 days in many jurisdictions)

Proposals to Use Ectogenesis for Space Exploration

- Prospect of populating space colonies in future to ensure survival of human race currently being considered
- **Embryo space colonization**: sending human embryos to space colonies to be developed via ectogenesis and android assistants (Edwards 2021)
- Artificial wombs could also be used to increase earth population, particularly following mass extinction events (Edwards 2021)
- Dangers are associated with reproduction in space such as health concerns (e.g., radiation exposure and microgravity) and the allocation of carefully planned resources, which the controlled environment of ectogenesis could mitigate (Kendal 2021)



[...] If there aren't enough people for Earth, then there definitely won't be enough for Mars

We should be investing in technology that makes having kids much faster/ easier/ cheaper/more accessible. Synthetic wombs etc

Verbatim Twitter conversation between Elon Musk & Sahil Lavingia See Friedersdorf (2022)

Theoretical Framework for Analysis

- An analysis of the **legal and ethical issues** presented by the proposed use of ectogenesis for space exploration, with consideration of the rights of potential child(ren) born in space via ectogenesis, reproductive rights, legal parental responsibility for such child(ren), best interests principles, and other bioethical considerations



Methodology

- Doctrinal methodology
- Identification & refining of research question, review of literature, analysis of gaps/ analogous contexts, identification of legal and ethical issues, evaluation of findings, drawing of conclusions, and presentation of results

Research Question

To date, much of the literature on ectogenesis and space focuses on whether ectogenesis and space colonization may be *practically possible*, with limited focus on the significant **legal and ethical issues** using ectogenesis in this context would pose. Further, while the **general issues** related to partial and complete ectogenesis have been considered in the literature, there is an absence of legal and ethical analysis on the use of ectogenesis for such specific purpose (space colonisation).

What are the main legal and ethical issues presented by the proposed use of ectogenesis for space colonisation?

Research Findings

1. Legal Status of the Fetus & the Right to Citizenship

- Human rights dependent on **birth** in many jurisdictions & international human rights laws, e.g., Art 2 ECHR, right to life of 'everyone' interpreted as not including fetus, see **Vo v. France** [GC]; **Evans v. the United Kingdom** [GC]
- What would the **legal status** of a fetus completely gestated in an artificial womb be? May be granted special protection with recognition of its interests but no rights until 'birth', in line with naturally gestated fetus, or may result in a **legal fiction** whereby status of ectogenetic fetus differs to *in vivo* fetus
- Questions further complicated by gestation in outer space – rights often attached to citizenship as this dictates **which State has legal responsibility** for that citizen (Ní Ghráinne & McMahon 2017) Citizenship laws usually affected by i. **legal parentage**, or ii. **jurisdiction** born in - however, uncertain who would have legal parentage and laws of which jurisdiction would apply to determine status/ interests/ rights of children born in this way in space
- Compare with **maritime law** and **aviation law** – laws of the state the vessel is registered to – if return to earth – stateless, citizen of country vessel registered to, citizen of parents' state or citizen of space colony?
- **United Nations Outer Space Treaty (1967)** - space is not subject to national appropriation – exploration should be for benefit of all – makes no reference to citizenship of those gestated & born in space

2. Consent & Best Interests Considerations

- Distinction between an adult consenting to leave earth and a child born in space – would this require **informed consent** from parents, or if donor embryos are used, the informed consent of the progenitors?
- Best interests considerations and ethical concerns for children born in space, including **health, parenting, and socialisation** concerns
- No specific legislation exists to ensure protection of rights and interests in this context – concerns of vindication of the rights to life, health, etc. of child(ren) born

3. Commodification

- Whether it is appropriate to create children via ectogenesis for a specific purpose (space colonisation) and whether this opens the floodgates to allow children to be created for nefarious means, e.g., armies, child labourers, organ retrieval
- Potential **utilitarian approach** if necessary for survival of human race? Broader human rights issues in this context

Conclusions

- Though complete ectogenesis likely not possible until distant future, interest is growing around its potential future uses, including **unforeseen potential uses for assisted human reproductive technologies**, such as space exploration
- **Regulation** is needed in anticipation of the ectogenesis to ensure the **rights and interests** of the fetus/child born are protected in this context; a clear understanding of the **status, rights, and interests** of the fetus/child born via ectogenesis is fundamental to understanding how to apply these to the fetus potentially gestated via ectogenesis in the space colonisation context
- No legislation exists regulating this potential future use of ectogenesis - look to existing laws & regulation in related areas which may inform future legislation

Selected References

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