From research to biobanking - The unique informative value of the human placenta

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The Early Life Exposome

Explored by Human biomonitoring (HBM) studies (exposure) accompanied by functional *in vitro* studies on placental cells (barrier function of the placenta)

Human Biomonitoring (HBM) studies

Period	Study site	Study group	Matrix	Exposure Marker	Effect Marker	Genetic Marker	*In vitro* Tox
1999-2000	Austria	**Nursing women** (N=165)	Breast milk	Hg, Pb			
2004-2005	Austria	**General population** (N=159)	Blood	Hg, Pb			
2005-2007	Austria	**Mother-newborn-pairs** (N=53)	Blood, urine, hair, placenta, meconium, breast milk	Hg, MeHg, Pb	Birth outcome		
2005-2007	Austria	**Students** (N=324)	Blood, urine, hair	Hg, Pb		SNPs Gene expression	
2005-2008	Austria	**Children** (N=449)	Hair, milk teeth	Hg, Pb			
2010-2011	Mongolia	**Gold miners** (N=250)	Hair, urine	Hg			
2010-2012	Vienna-Bratislava	**Mother-newborn-pairs** (N=200)	Blood	Hg, MeHg, Pb BPA, PFAS	Birth outcome	SNPs	
2012-2013	Congo	**Mother-newborn-pairs** (N=48)	Blood	Pb			
2012-2015	Austria	**Mother-newborn-pairs** (N=116)	Blood, placenta	Hg		SNPs Gene expression	✓
2016-2020	Austria	**Mother-newborn-pairs** (N=300)	Blood, placenta	Hg, PFAS	Pregnancy disease (SGA, FGR, PE)	SNPs Gene expression	✓
2017-2022	Austria	**Mother-newborn-pairs** (N=136)	Blood, placenta	Fe, Cd, Pb	Iron status	Gene expression	✓

Gundacker et al. 2002, 2007, 2009, 2010, 2021, Straka et al. 2016, Balthasar et al. 2017, Forsthuber et al. 2020, Widhalm et al. 2020, Granitzer et al. 2020,2021

The maternal-fetal interface placenta

is an upstream organ of the fetus

performs the functions of fetal lungs, liver, intestines, kidneys and glands as long as these organs are not fully functional

Functions include gas exchange, transfer of nutrients and metabolites, hormone secretion, and transfer of immunoglobulins

Proper formation and function of the organ is crucial for fetal development

Placental dysfunction increases the risk of complications for mother and child during pregnancy and childbirth

Placental health predisposes for health and disease in later life (DOHaD hypothesis)

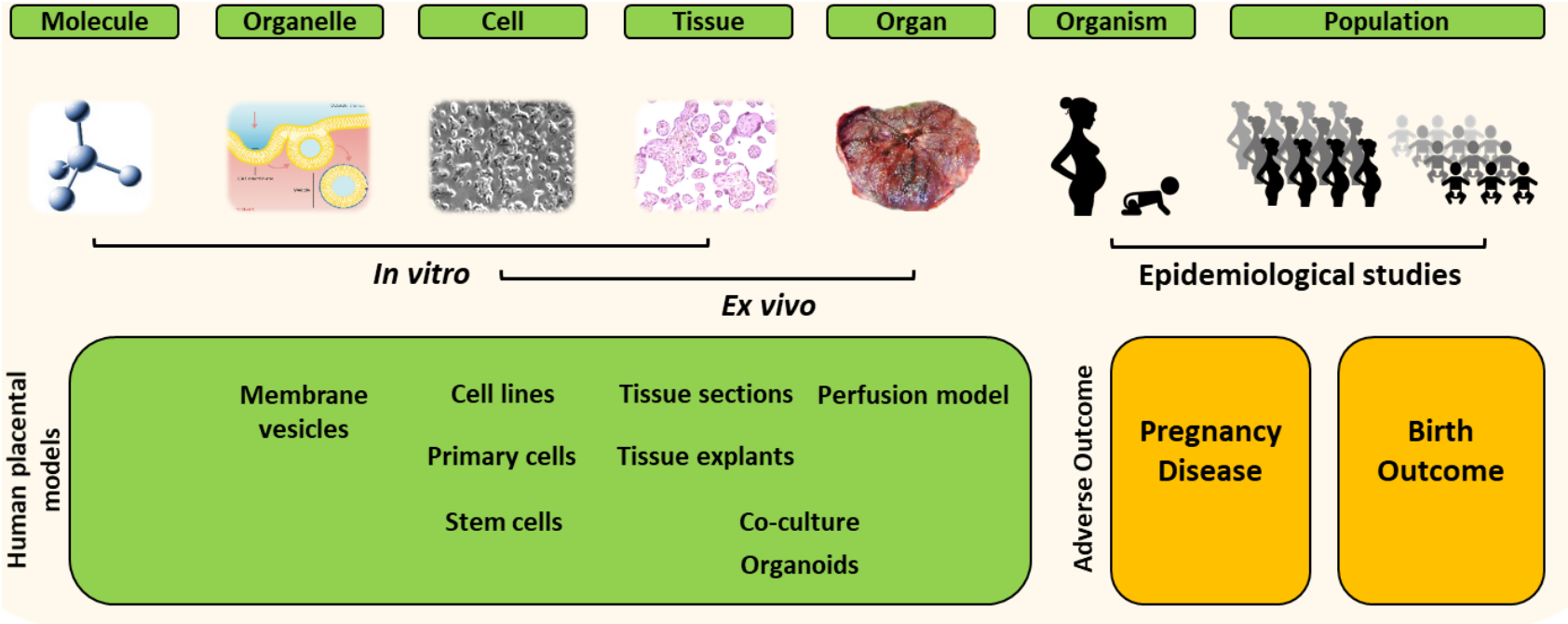
Placental health and birth outcome

Most pregnancy-associated disorders such as pre-eclampsia (PE), fetal growth restriction (FGR) and gestational diabetes mellitus (GDM) **are caused by or associated with placental dysfunction**

PE: high risks of iatrogenic preterm delivery, fetal growth restriction, placental abruption, and perinatal mortality, along with maternal morbidity and mortality. …**increased long-term risk of CVD in both the mother and child**
FGR: greatest risk factor for stillbirth, also **linked with cardiovascular, respiratory, neurological and other morbidities**
GDM: **long-lasting health consequences**, for both mother (e.g. increased risk for T2D and CVD), and child (e.g. obesity, CVD, T2D,..)

Gundacker and Ellinger (2020). The unique applicability of the human placenta to the Adverse Outcome Pathway (AOP) concept: the placenta provides fundamental insights into human organ functions at multiple levels of biological organization. *Reprod Toxicol, 96, 273-281.*

Research on the human placenta: the possibilities

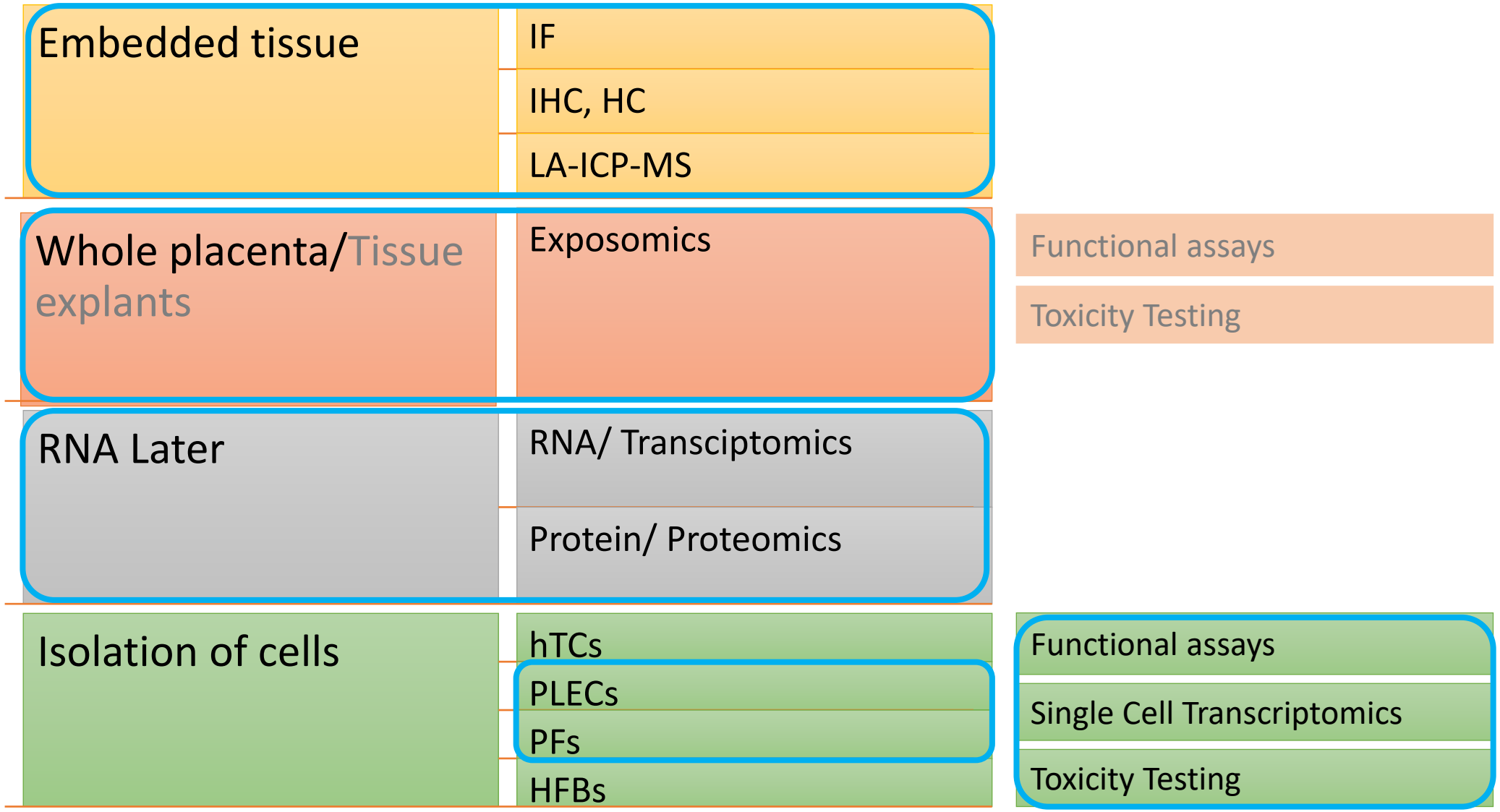


Gundacker, C., & Ellinger, I. (2020). The unique applicability of the human placenta to the Adverse Outcome Pathway (AOP) concept: the placenta provides fundamental insights into human organ functions at multiple levels of biological organization. Reprod Toxicol, 96, 273-281. https://doi.org/10.1016/j.reprotox.2020.07.014

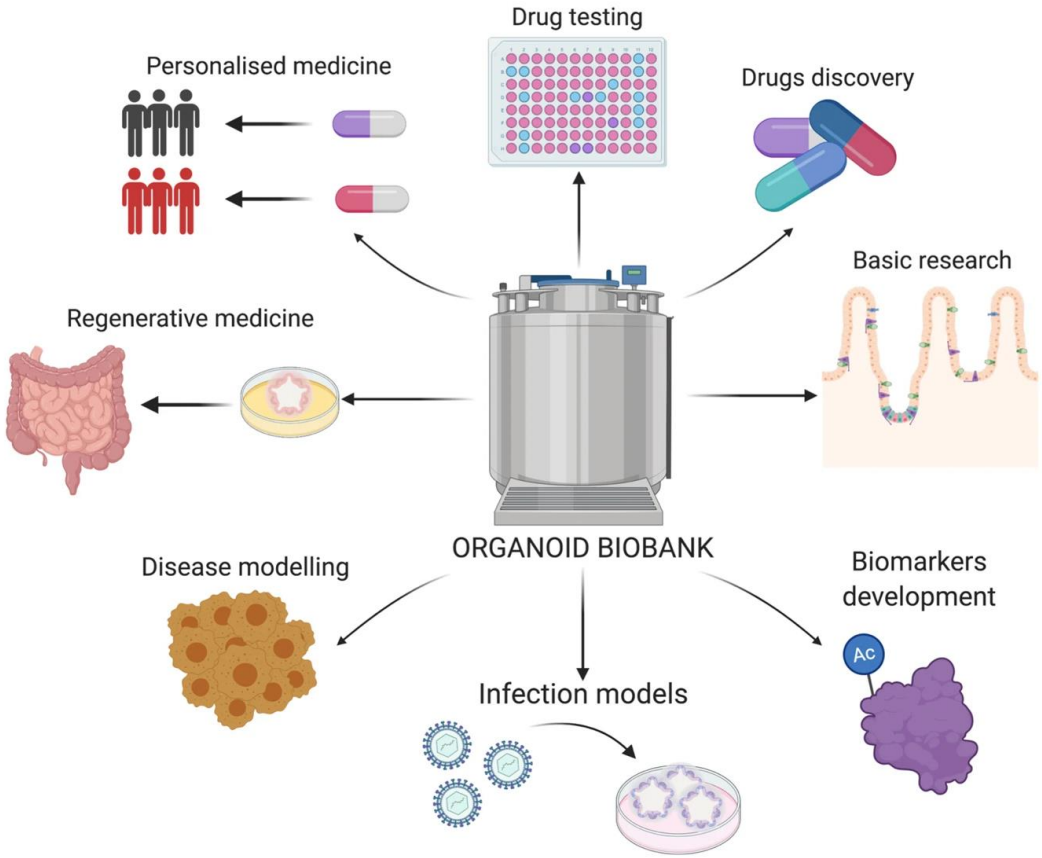
The placenta is available
It provides fundamental insights into human organ functions

From research to biobanking

Placenta



Next generation biobanking



"…compared to traditional tissue repositories, the generation of a living organoid biobank requires a much higher level of coordination, additional resources, and scientific expertise."

Perrone, F., & Zilbauer, M. (2021). Biobanking of human gut organoids for translational research. *Experimental & Molecular Medicine, 53(10), 1451-1458. https://doi.org/10.1038/s12276-021-00606-x*

Concluding remarks

The placenta is available
Cells/tissue of healthy and diseased placentas can be stored (RNA/protein can be stored indefinitely)
Cells of healthy and diseased placentas can be comparatively researched (PLECs and PFs also retrospectively)
Findings from epi studies can be explored/comfirmed ad-hoc and years after (hybrid studies)

Austrian Cohort including Birth Cohort
Longitudinal design
Paternal factors should be included