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Review Article

Embryogenetics: The Coalescence of Genetics and Embryology

Sperber GH[1]* and Sperber SM[2]

[1]*Faculty of Medicine & Dentistry, University of Alberta, Edmonton, Canada*

[2]*Department of Genetics & Genomic Sciences, Icahn School of Medicine at Mount Sinai, One Gustav L. Levy Place, New York, USA*

Abstract

The conjunction of the genetic and embryological sciences in the development of the human being. Optoacoustic technology is utilized in genetic analysis. The future of genetic engineering in "Big Data" analysis.

Keywords: DNA; Embryology; Genetics; Genomics; Morphogenesis

The launching of a new journal combining two previously disparate disciplines heralds a new era in the annals of human anatomy and developmental biology. The recent advances in embryology and genetics are increasingly integrating the interaction of genetic directives and embryological dispensation in the development of "De humani corporis fabrica" [1].

The founders of genetics, Mendel, Bateson, Dobzhansky and Muller could not have imagined the impact that their disciplines have had in advancing the developmental phenomena of embryology. Nor would the pioneers of embryology, their names embedded in Meckel's cartilage, the Eustachian tube, the Gasserian ganglion and the Malpighian corpuscles of the kidney have dreamt of their exploratory sciences being driven by genes that were only revealed by the sequencing of the human genome in 2001 [2]. Among the first textbooks to meld the two sciences were Scott Gilbert's "Developmental Biology" [3], Wolpert's "Principles of Development" [4] and Sperber's "Craniofacial Embryogenetics and Development" [5]. These books integrate embryological phenomena driven by genetic signaling networks.

The detailed identification of discrete components of the constantly changing developing embryo by sophisticated selective contrast agent technology [6] and gene expression techniques allows for ascription of individual genetic factors and signaling influences to be recognized at different stages of development. Thus, the expression pattern of cell cycle genes, captured by new bio-imaging techniques of optical projection tomography and photoacoustic imaging provide information on the developing embryo [7]. These imaging techniques in combination with reporter genes are revealing in remarkable detail the intricate processes of proliferation, cell differentiation, migration and morphogenesis of individual components of embryogenesis. The identification of the expression patterns of individual genes and their mutations allows for the experimental rescue of deviant developmental pathways. Therapeutic gene expression intervention provides the possibility of prevention of congenital anomalous development. An example of following vasculogenesis, brain and limb patterning linked to retinoic acid homeostasis is revealed in studies of mouse mutants [8].

Similarly, using microarray technology to investigate gene expression of cells in what histologically is a distinct singular tissue, bone, reveals by gene expression signatures to be embryologically a diverse origin of bones [9]. Herein is the micromolecular investigation of embryogenetic origins of tissues and organs revealing the complexity of human development. The potential for genetic modification of human embryos has been realized by genome editing of disease loci [10,11]. The promise of "big data" analyzing massive amounts of information on an unprecedented scale, making "geno-embryo" connections will aid in the discovery of gene networks and help our understanding of the mechanisms of development [12]. The impact of disease genes on maldevelopment is evident in craniofacial malformations [13].

These experimental studies provide the rationale for human clinical applications in preimplantation genetic diagnosis, a fast expanding field of medical practice. The capability of prognosing potentially severely impaired or fatal genetic diseases in an embryo before uterine implantation has huge implications for impending parental decisions and ethical, legal, sociological and theological considerations for human society. The capability of selecting *in vitro* fertilized embryos for particular traits, or for providing stem cells to counteract genetic diseases in siblings is an issue becoming of significance. And the editing of zygotes that will allow genetic modification of human embryos is raising huge ethical issues [14].

In advancing inquiry into human embryological origins by genetic analysis of DNA, the current micromolecular dissection of developmental phenomena is paradoxically extending the investigation of human evolution by paleogenomics. The sequencing of ancient DNA in fossil hominin specimens is revolutionizing the science of paleoanthropology [15]. The simultaneous expansion both backwards and forwards of the history of human development makes the present era of revelations as exciting as current planetary exploration.

***Corresponding author:** Sperber GH, Faculty of Medicine & Dentistry, University of Alberta, Edmonton, Canada, Tel: +1 7804925194; Fax: +1 7804927536, E-mail: gsperber@ualberta.ca

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