The Zebrafish Experimental Conditions Ontology

Systemizing Experimental Descriptions in ZFIN

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***Abstract*— The Zebrafish Experimental Conditions Ontology (ZECO) defines the major experimental conditions used in research studies that employ the zebrafish, *Danio rerio*. We are systematically building the ontology to encompass both standard control conditions and experimental conditions and it is designed to allow better data curation and more precise information retrieval.**

Keywords—zebrafish; Danio rerio; experimental conditions; ZECO

I. Introduction

Zebrafish are an aquatic model organism utilized extensively for cellular, molecular, developmental, genetic, and disease associated research. Zebrafish are easily manipulated research animals and as such are subjected to experimental conditions which range from amputation to chemical application via food or tank water, to manipulation of lighting conditions. To facilitate the annotation of experimental conditions used in zebrafish research the Zebrafish Model Organism Database (ZFIN) has developed the Zebrafish Experimental Conditions ontology (ZECO).

II. Results and Discussion

A. An applied ontology

ZECO is an applied ontology which will be deployed at ZFIN to effectively annotate gene expression, phenotypes, and human disease models that are a result of the genetic and/or experimental conditions applied to zebrafish. The concise annotation of experimental conditions allows for the differentiation of phenotypes and perturbations of gene expression that result from genetic manipulation versus those resulting from environmental or experimental condition manipulation. Phenotypes influenced by environmental or experimental treatment can be as diverse as a change in behavior or a change in disease state. For example, environmental conditions such as diet play a large part in human morbidity and mortality. Components of the zebrafish diet such as sugar, fat, or protein can be altered to replicate observed human diet composition allowing for the exploration of how diet can affect the etiology of various phenotypes and human diseases.

B. Design specifications

The ZECO hierarchy is developed according to the major types of experimental and environmental conditions used in zebrafish research. The high level nodes include biological treatment, chemical treatment, diet, housing conditions, *in vitro* culture, surgical manipulation, lighting conditions, temperature exposure, radiation exposure and water quality. Biological treatments deal with experimental conditions where there is either the addition or subtraction of another organism from the fish and/or the environment and can be used to denote both pathogenic and commensal interactions. The chemical treatment branch of the ontology is designed to be post-composed [1] with the Chemical Entities of Biological Interest ontology (CHEBI) [2] to allow specification of the exact chemicals used in the experiment. This design decision allows for the creation of needed experimental conditions on the fly without having to enumerate all possible chemicals used within the ontology. A similar design strategy can be used for surgical manipulation, ablation and resection of particular anatomical structures by post-composing with the Zebrafish Anatomical ontology (ZFA) [3], thus allowing more precise enumeration of surgically manipulated entities. The other high level nodes of housing conditions, lighting conditions, temperature exposure and water quality are meant to allow for the annotation of tank conditions that the zebrafish is exposed to during the course of the experiment.

In its rudimentary form ZECO is a simple is_a hierarchy. As development of the ontology proceeds certain classes will have multiple inheritance either via declared or inferred relationships. Additionally classes that inherently reference either chemicals, like dietary fat, or anatomy, like retina puncture, will have a reference to the appropriate term from CHEBI or ZFA in the logical definition. The goal is to deposit ZECO at the Obo Foundry which requires ontologies to be extensible and interoperable [4]. ZECO was developed due to the lack of an existing ontology that effectively covered the unique experimental conditions applied to zebrafish. In the future ZECO could be rooted as the aquatic branch of a larger environmental ontology, which could include the rat Experimental Conditions Ontology (XCO)[5] and the Plant Environment Ontology (EO)[6] which would cover all experimental conditions encountered by model organisms.

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REFERENCES

[1] C. J. Mungall, M. Bada, T. Z. Berardini, J. Deegan, A. Ireland, M. A. Harris, D. P. Hill, and J. Lomax, "Cross-product extensions of the Gene Ontology.," J. Biomed. Inform., vol. 44, no. 1, pp. 80–6, Feb. 2011.

[2] C. Hastings, J., de Matos, P., Dekker, A., Ennis, M., Harsha, B., Kale, N., Muthukrishnan, V., Owen, G., Turner, S., Williams, M., and Steinbeck, "The ChEBI reference database and ontology for biologically relevant chemistry: enhancements for 2013," Nucleic Acids Res., vol. 41, no. Database, pp. D456–D463, 2013.

[3] C. E. Van Slyke, Y. M. Bradford, M. Westerfield, and M. A. Haendel, "The zebrafish anatomy and stage ontologies: representing the anatomy and development of Danio rerio.," J. Biomed. Semantics, vol. 5, no. 1, p. 12, Jan. 2014.

[4] "OBO Foundry Principles 2008." [Online]. Available: http://obofoundry.org/wiki/index.php/OBO_Foundry_Principles_2008.

[5] M. Shimoyama, R. Nigam, L. S. McIntosh, R. Nagarajan, T. Rice, D. C. Rao, and M. R. Dwinell, "Three ontologies to define phenotype measurement data.," Front. Genet., vol. 3, p. 87, 2012.

[6] R. L. Walls, B. Athreya, L. Cooper, J. Elser, M. A. Gandolfo, P. Jaiswal, C. J. Mungall, J. Preece, S. Rensing, B. Smith, and D. W. Stevenson, "Ontologies as integrative tools for plant science.," Am. J. Bot., vol. 99, no. 8, pp. 1263–75, Aug. 2012.