UNIVERSITY of GUELPH

COLLEGE of BIOLOGICAL SCIENCE

DEPARTMENT OF MOLECULAR AND CELLULAR BIOLOGY

Announcement:

All interested members of the university community are invited to attend the Final Oral Examination for the degree of ***Doctor of Philosophy*** *of*

JENELLE PATTERSON

on Monday, February 26, 2018 at 1:30 p.m. in SSC 1511

Thesis Title: **Post-translational regulation of *Arabidopsis thaliana* starch synthase 2**

Examination Committee:

Dr. A. Bendall, Dept. of Molecular and Cellular Biology (Exam Chair)
Dr. I. Tetlow, Dept. of Molecular and Cellular Biology
Dr. R. Mullen, Dept. of Molecular and Cellular Biology
Dr. B. Micallef, Dept. of Plant Agriculture
Dr. A. Myers, Dept. of Plant Biology, Iowa State University

Advisory Committee:

Dr. M. Emes (Adv)
Dr. I. Tetlow (co-adv)
Dr. M. Kimber

Abstract: Starch is the main carbohydrate storage molecule in plants. In photosynthetic tissues, it is produced during the light-period and degraded at night to support cellular respiration. Starch is synthesized by the coordinated actions of multiple enzyme classes, including starch synthases (SS) and starch branching enzymes (SBE). The starch synthase 2 (SS2) isoform is important in starch synthesis, elongating intermediate-length glucan chains, and its loss results in distorted starch granules with altered physiochemical properties. Despite its importance in starch biosynthesis, the regulation of SS2 is poorly understood. In this study, post-translational mechanisms that potentially regulate SS2 were identified. The SS2 N-terminal region, comprised of the first 185 amino acids of the mature protein sequence, is highly variable between species and appeared to be intrinsically disordered. Recombinant SS2 formed homodimers that required the N-terminal region, but N-terminal peptides could not form stable homodimers alone. Recombinant SS2 was phosphorylated by chloroplast protein kinases and recombinant casein kinase (CK) II at two N-terminal serine residues (S63, S65). Inhibition of chloroplast-dependent SS2 phosphorylation by heparin reinforced the role of stromal CK's in this process. SS2 phosphorylation did not affect its catalytic activity, but monomeric SS2 was more active than homodimers, suggesting that SS2 activity might be regulated by its oligomeric conformation. Complex formation between SS2 and SBE2.2 was shown to be ATP-dependent, but not dependent on SS2-specific phosphorylation or homodimerization. In summary, SS2 is post-translationally regulated by protein phosphorylation and homodimerization, for which its N-terminal region is required, and transitions between oligomeric states may regulate its catalytic activity.

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Curriculum Vitae:

Jenelle obtained her Bachelor of Science (Honours) in Plant Science (Biotechnology) in 2012 at the University of Guelph. She started her M.Sc. in 2012 and later transferred to the Ph.D. program in 2014 in the lab of Drs. Michael Emes and Ian Tetlow.

Awards:

Associate Vice-President Academic (AVPA) Teaching Assistant Award of Excellence, University of Guelph, 2017.

College of Biological Science Graduate Teaching Assistant Award of Excellence, University of Guelph, 2016.

Class of OAC'60 Award for Outstanding Teaching Assistant, University of Guelph, 2015.

Publications:

Patterson, J.A., Emes, M.J., Tetlow, I.J., Starch Synthesis. In Brian Thomas, Brian G Murray and Denis J Murphy (Editors in Chief), Encyclopedia of Applied Plant Sciences, Vol 1, Waltham, MA: Academic Press, 2017, pp. 570–576.

MacNeill*, G. J., Mehrpooyan*, S., Minow*, M. A. A., **Patterson*, J. A,** Tetlow, I. J., and Emes, M. J. 2017. Starch as a source, starch as a sink: the bifunctional role of starch in carbon allocation. Journal of Experimental Botany 68 (16): 4433-4453. *Co-first authorship

Makhmoudova, A., Williams, D., Brewer, D., Massey, S., **Patterson, J.,** Silva, A., Vassall, K. A., Liu, F., Subedi, S., Harauz, G., Siu, K. W. M., Tetlow, I. J., and Emes, M. J. (2014). Identification of Multiple Phosphorylation Sites on Maize Endosperm Starch Branching Enzyme IIb, a Key Enzyme in Amylopectin Biosynthesis. Journal of Biological Chemistry 289 (13): 9233–9246.