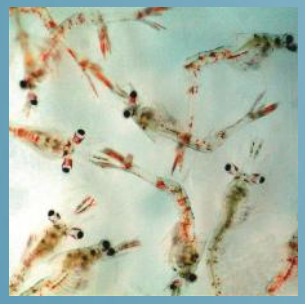
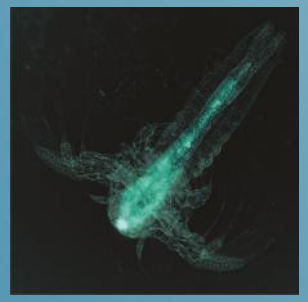
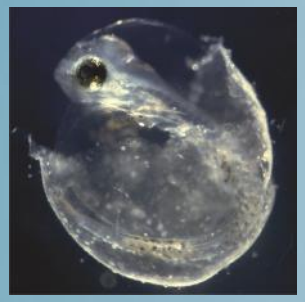
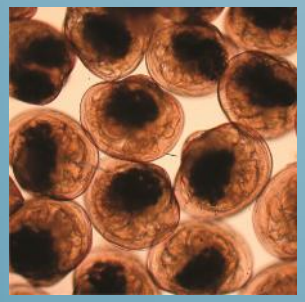




larvi 2013

6th fish & shellfish larviculture symposium

Ontogeny of the redox balance during organogenesis in Atlantic cod (Gadus morhua) larvae

Kristin Hamre

ghent university, belgium, 2-5 september 2013

ONTOGENY OF THE REDOX BALANCE IN RELATION TO ORGANOGENESIS IN ATLANTIC COD (GADUS MORHUA) LARVAE

Penglase 2011

Kristin Hamre, Samuel J. Penglase,
Josef D. Rasinger, Kaja H. Skjærven, Pål A. Olsvik
NIFES, Bergen, Norway

code
Cod Development

Larva NET

The redox balance

- Glutathione (GSH/GSSG) is present in all cells at high concentrations (1-10mM) and is considered important for determining the cell's average redox potential
- Other redox couples such as the CysSH/CysSSCys couple, the Thioredoxin couple, NADP(H) and reactive oxygen species (ROS) modulate the potential in microenvironments within the cells
- There are different redox potentials in
  - In different organelles within the cell
  - In different organs
  - Intra and extracellularly
- The redox potential is important for determination of metabolism and cell fate

The redox potential can be calculated using the Nernst's equation

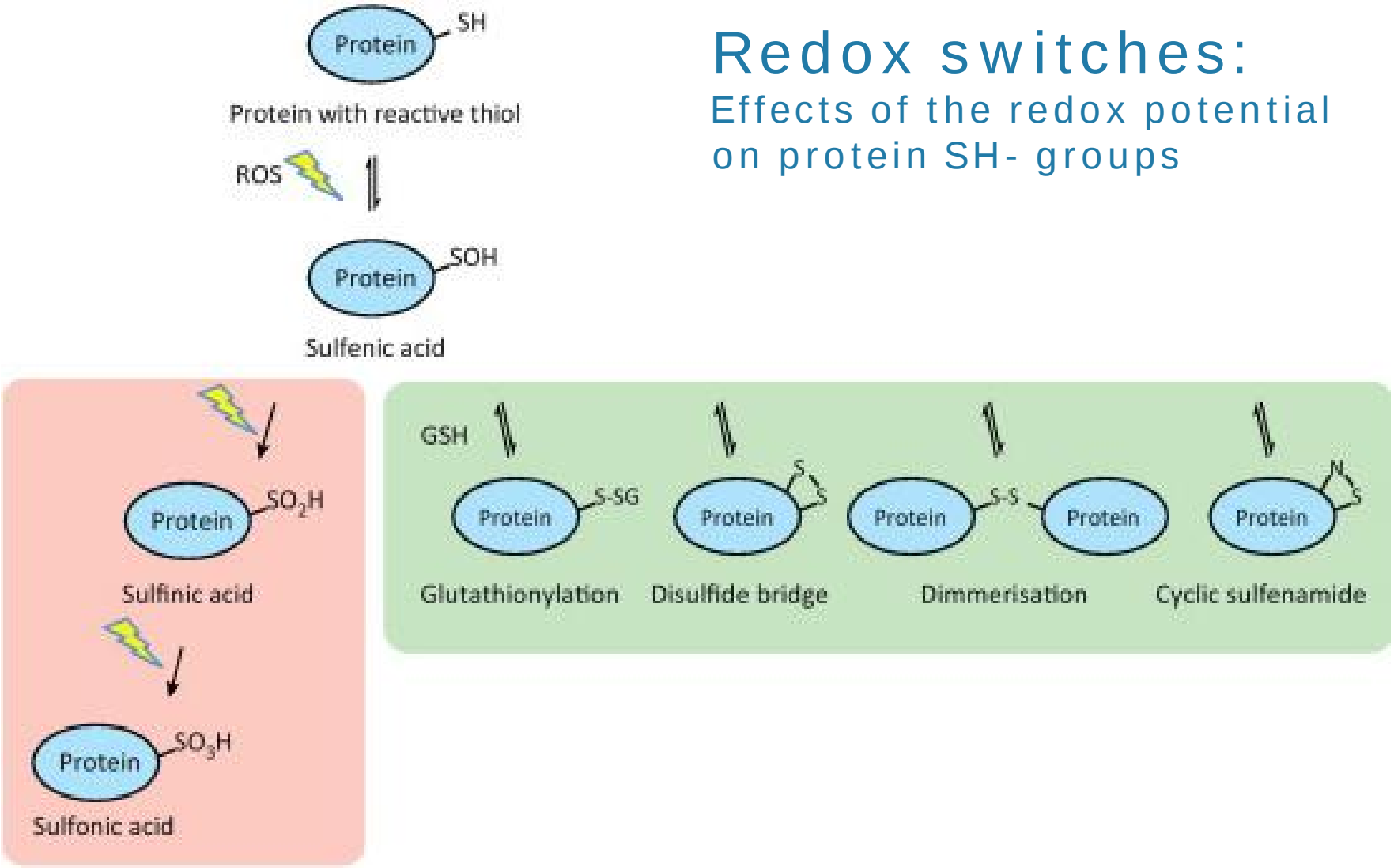
The potential of the GSH/GSSG couple :

$$E' = E'_0 - k * \text{Log} \frac{[GSH]^2}{[GSSG]}$$

- $E'_{0\ GSH/GSSG}$ = -240 mV (Scafer and Buettner 2001)
- The GSH/GSSG couple is not at equilibrium, the concentrations are at a steady state, which seems to be tightly regulated

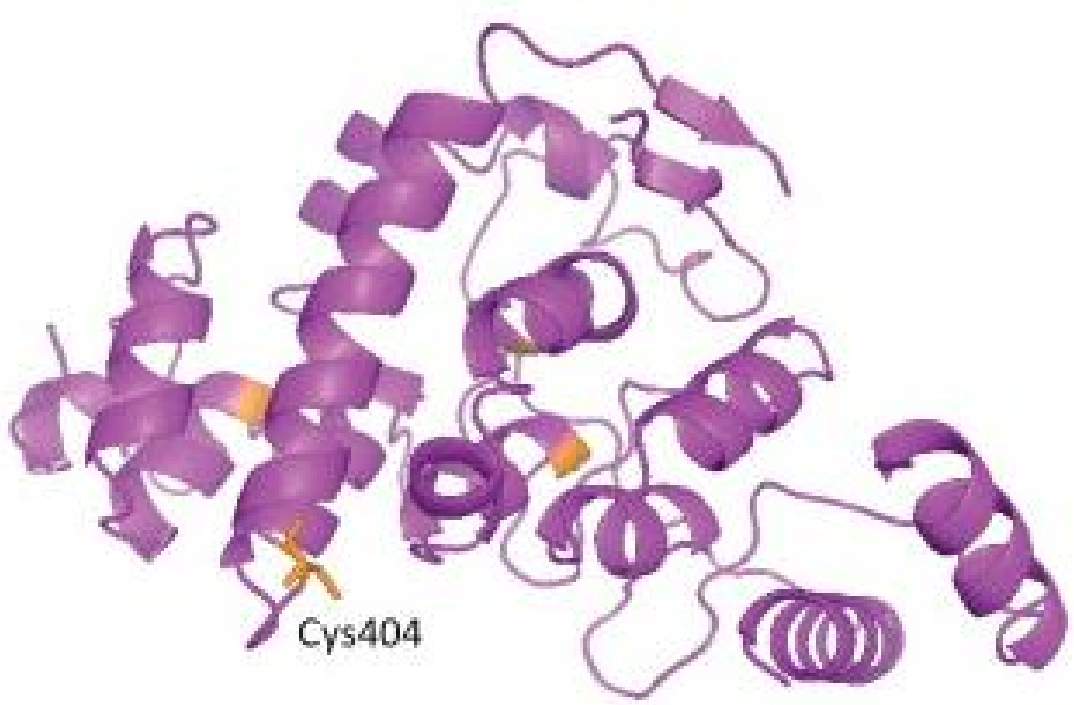
Redox switches:

Effects of the redox potential on protein SH- groups



Chiu and Dawes 2012

SS bonds and glutathionation change the 3-dimensional conformation of proteins



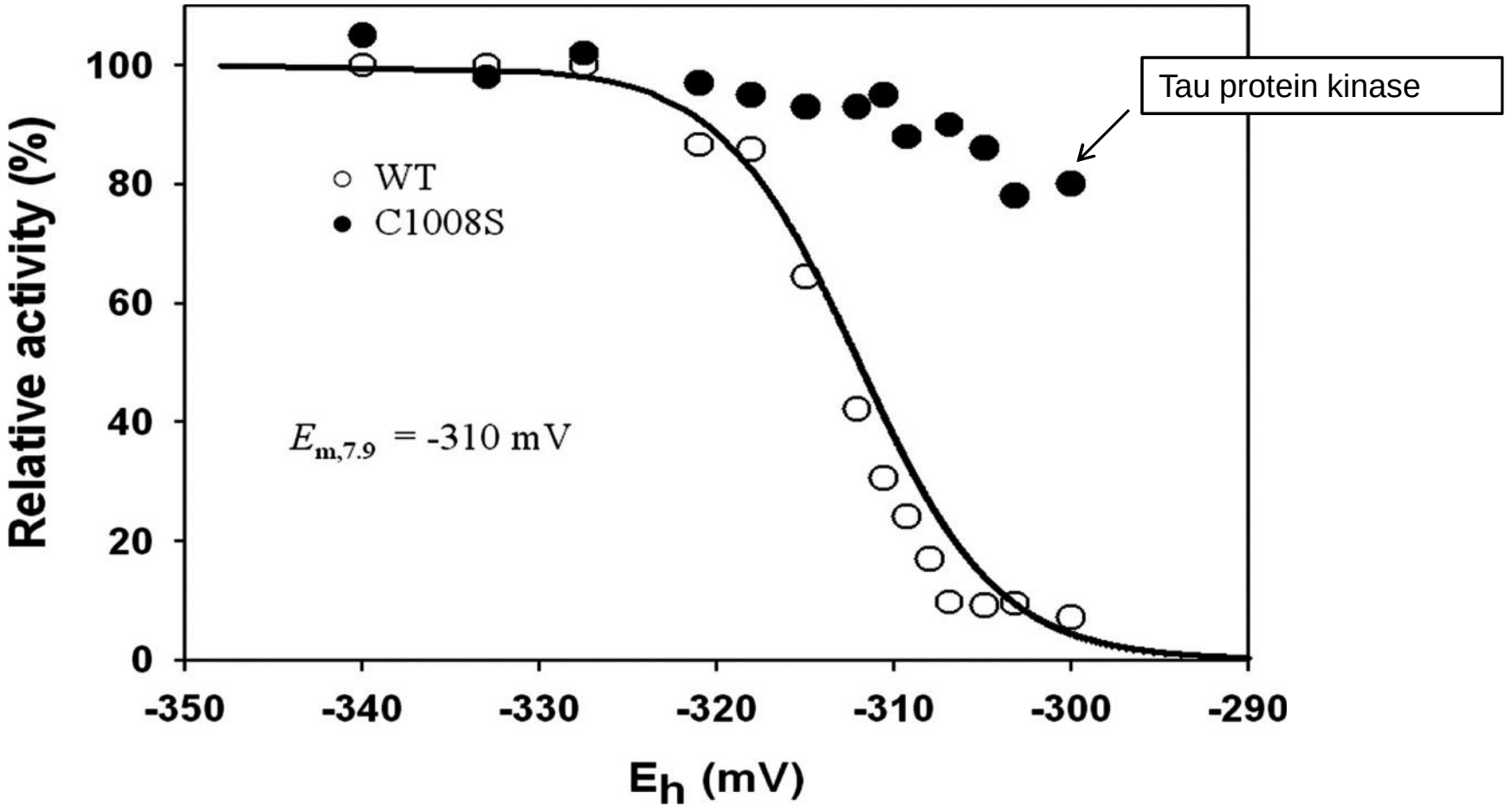
Enzymes
Structural proteins
Transcription factors
More…

Chiu and Dawes 2012

Enzyme activity affected by the redox potential

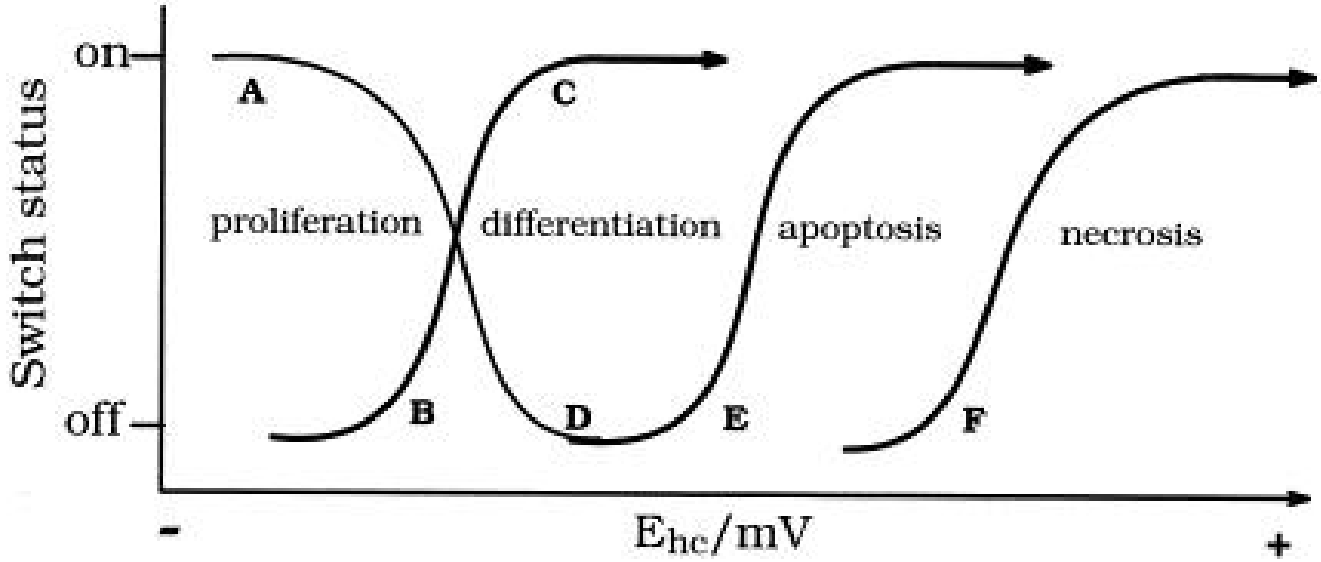
NIFES

Glucan, water dikinase (GWD): A plastidic enzyme with redox-regulated and coordinated catalytic activity and binding affinity



Mikkelsen et al., 2005

Redox potential and cell fate



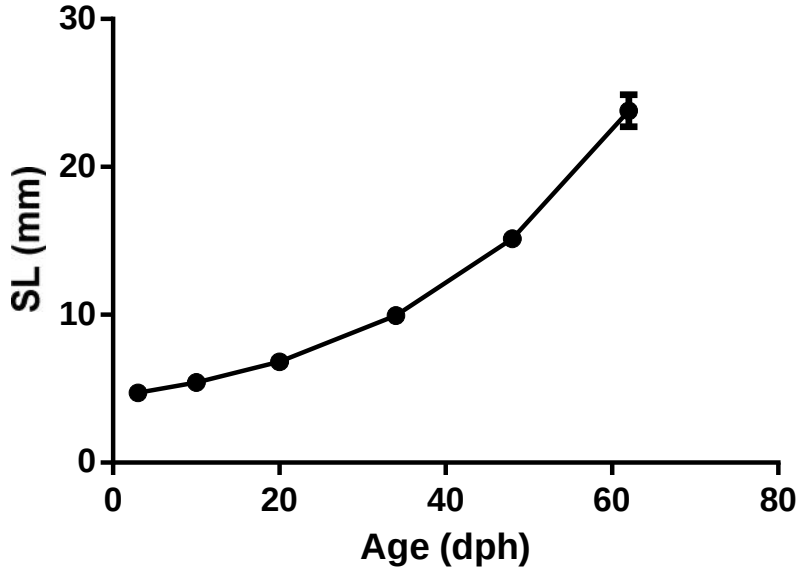
The normal range of potential in healthy cells is -200 to -260 mV

Schafer and Buettner 2001

How does this work in cod larvae?

- Cod larvae from triplicate tanks were sampled between 3 and 63 days post hatch from a commercial hatchery
- Whole larvae were pooled, and prepared for GSH, antioxidant enzyme analyses and qPCR

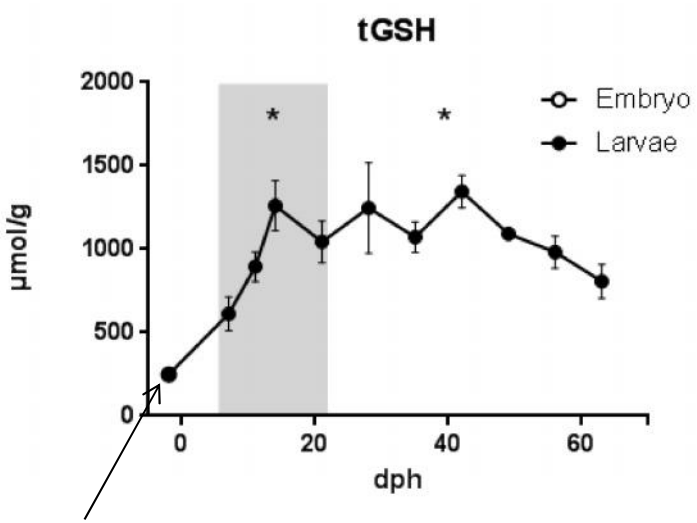
Standard length (SL) of sampled larvae and feeding regime



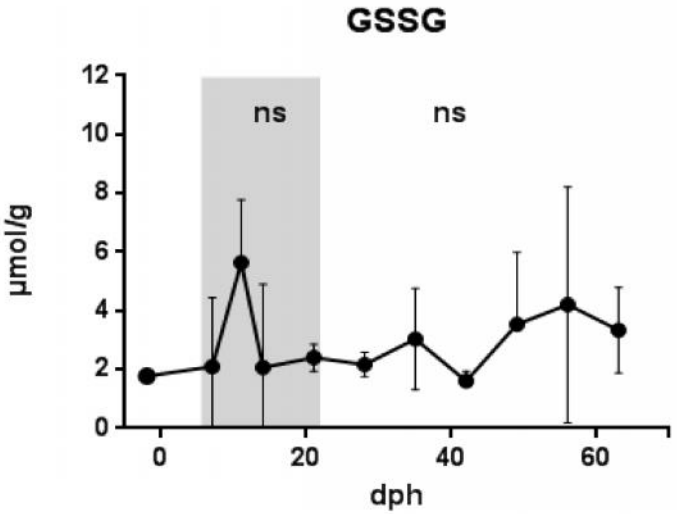
Rotifers

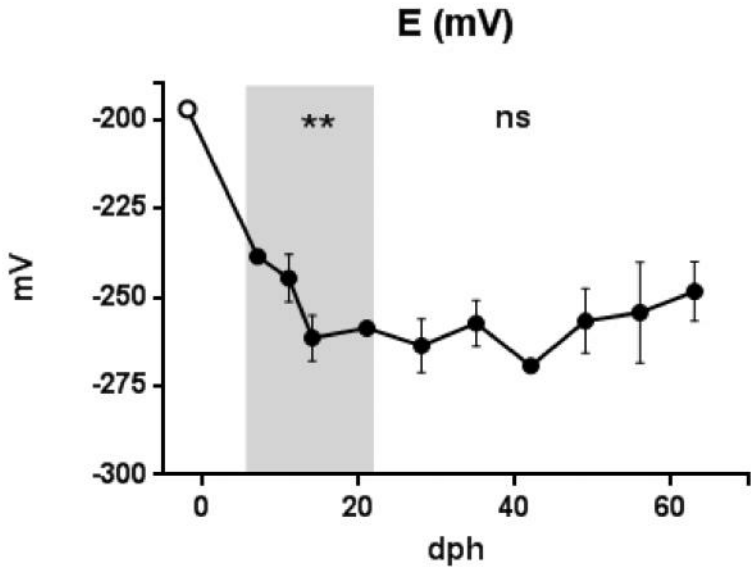
Formulated diet

The GSH based redox potential (E) in whole body of cod larvae

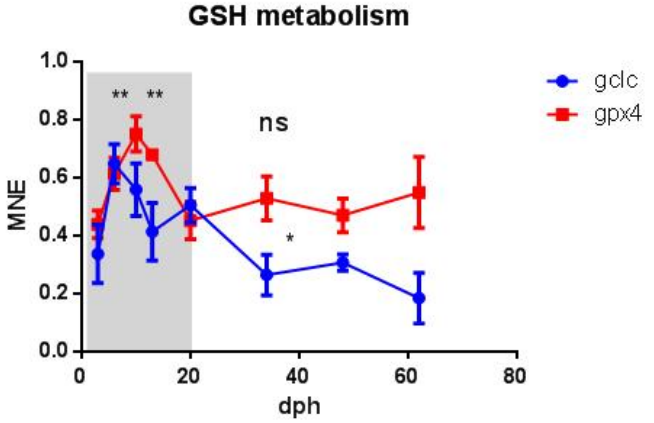


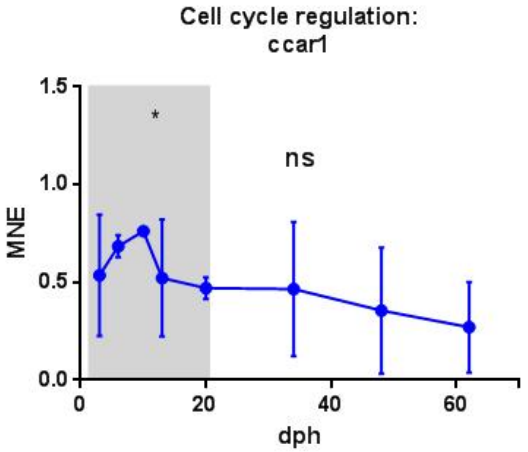
Skjærven et al 2013

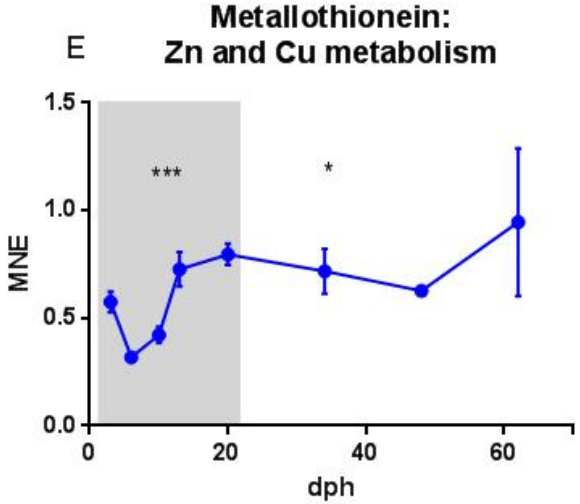


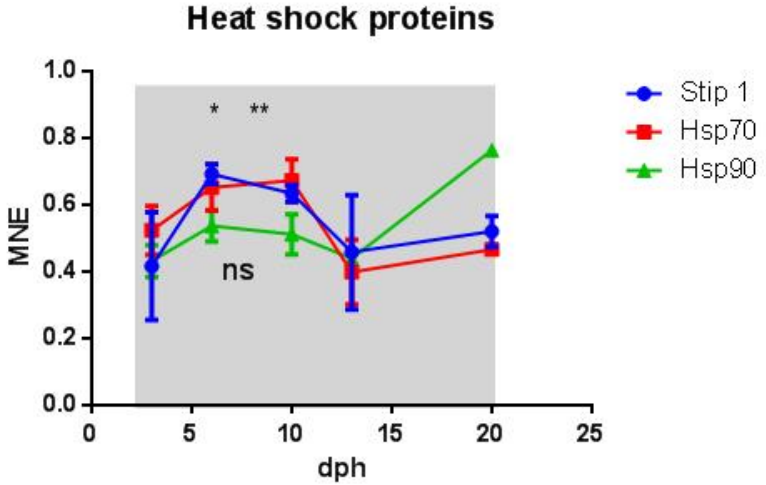


Correlation between GSH metabolism and cell cycle







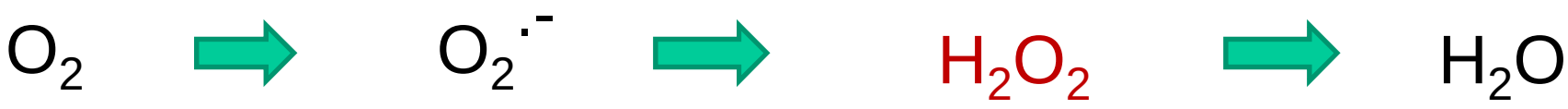


Metabolism of reactive oxygen species (ROS)

Nox enzymes
Mitchondrial respiration
Oxygenases

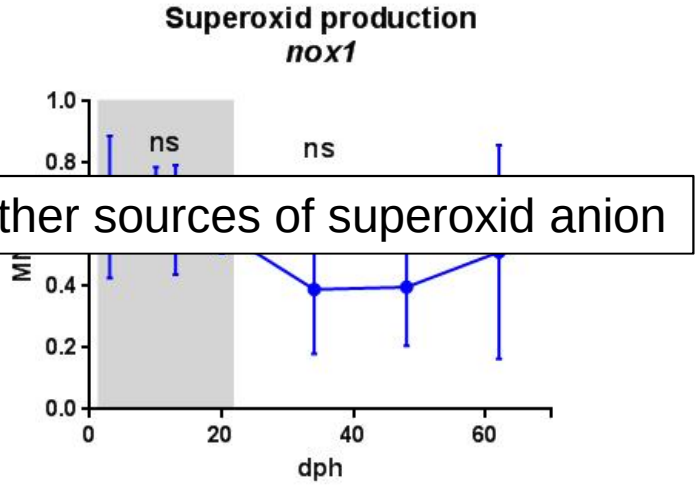
MnSOD
CuZnSOD

Gpx
Cat

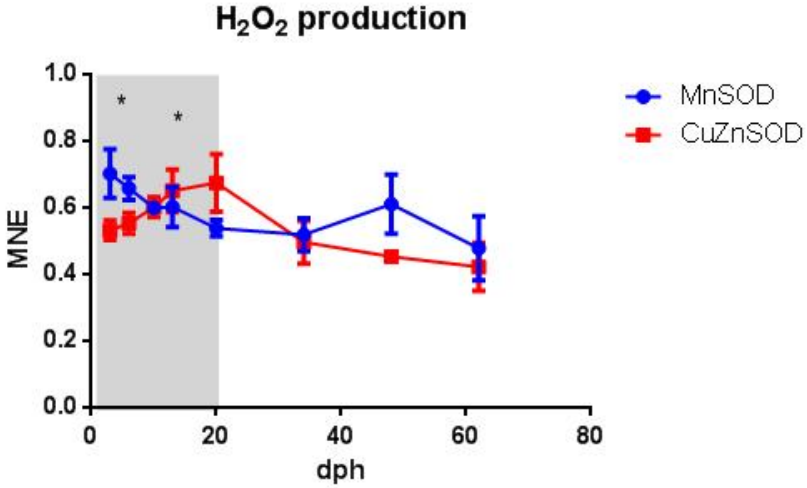


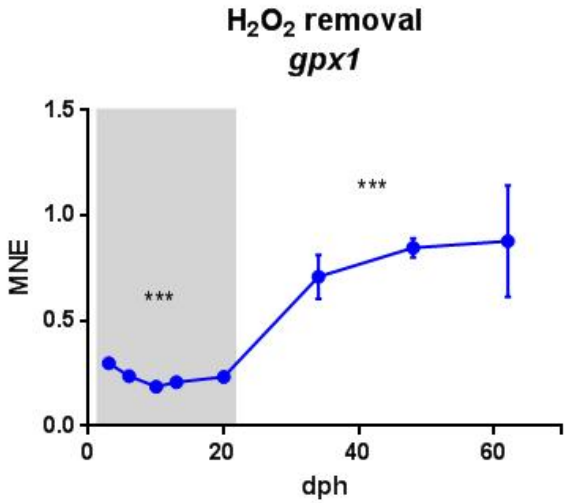
Superoxid anion

Signalling molecule
Diffuses through membranes

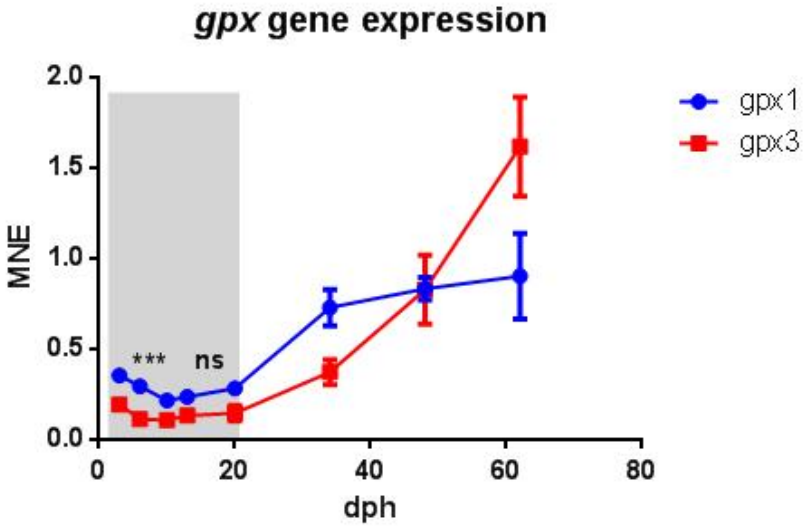


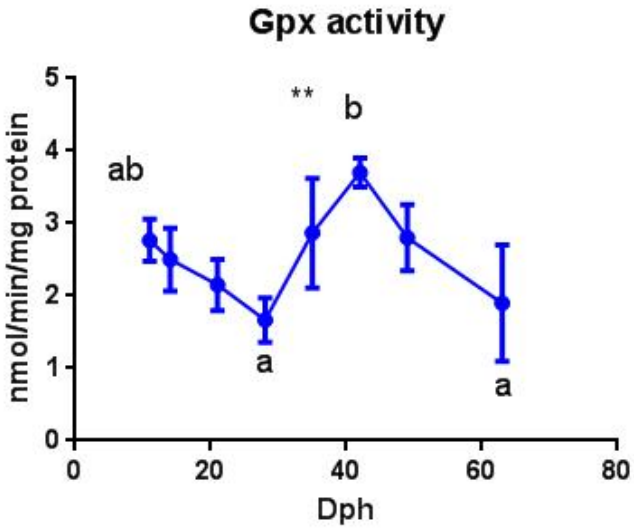
Other sources of superoxid anion



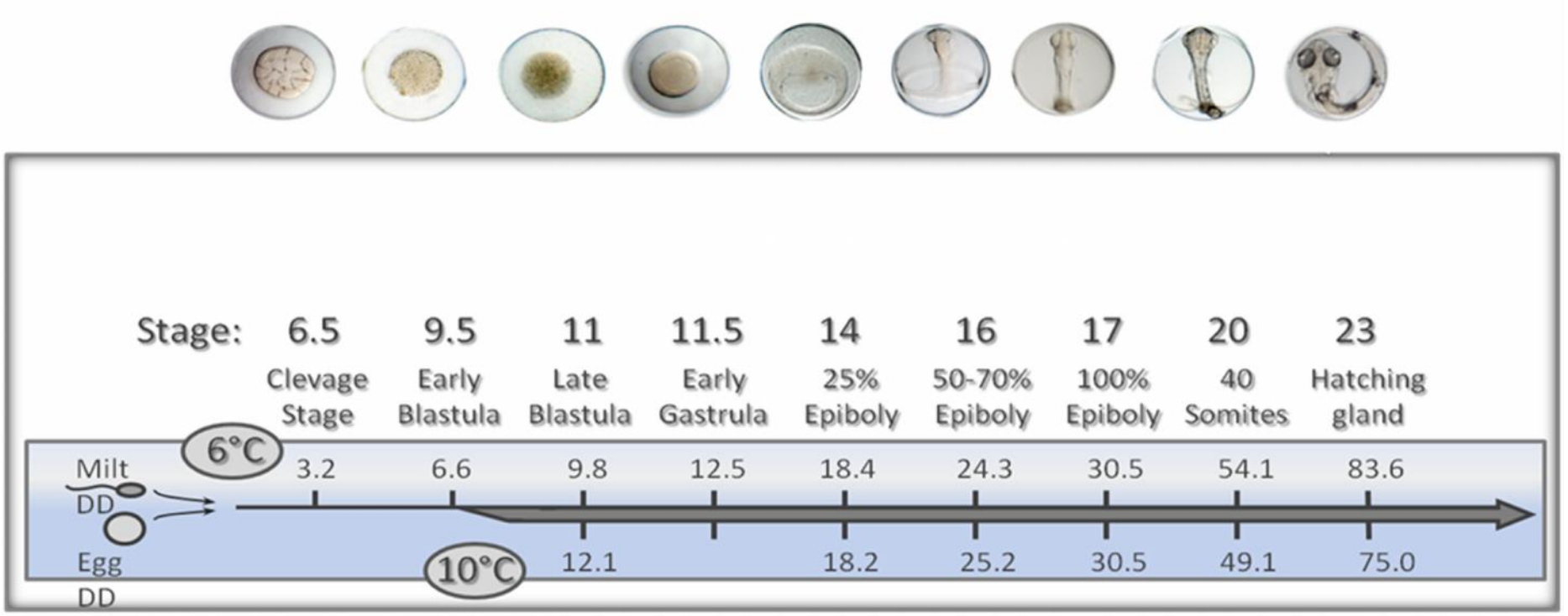


Not always correlation between gene expression and protein function



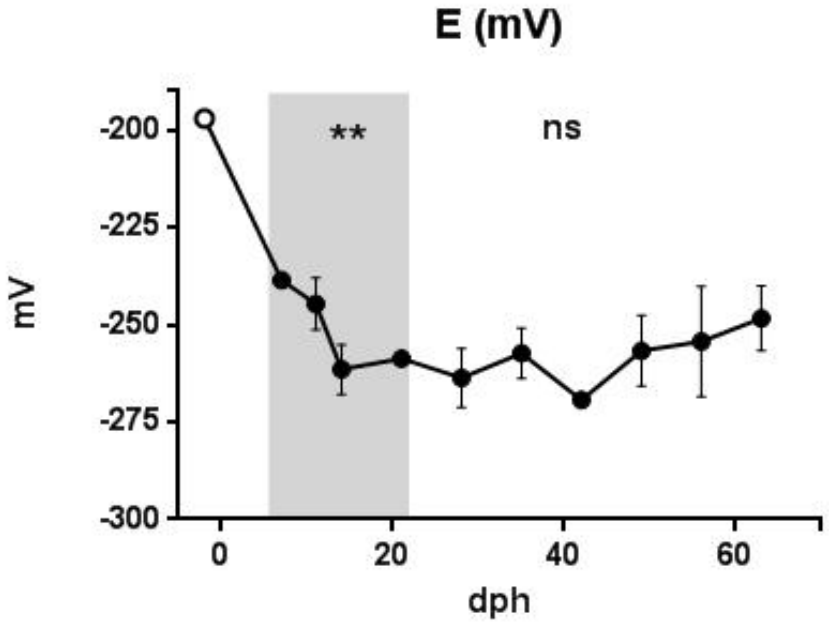


Proliferation and differentiation of cod embryos



Skjærven 2013

Proliferation, differentiation and apoptosis in cod larvae



We conclude with a hypothesis:
The early change in redox potential correlates with a change of main cellular mode from differentiation at hatching to proliferation after 13 dph

Thank you for your attention

- Funding:
  - The Research Council of Norway. Projects 79016/S40 and 99482/S40 Cod Development CODE
  - Larvanet
- Thanks to Marine Harvest Cod for samples
- Thanks to NIFES technicians for analyses