

# The Relation of Nodal Signaling Pathway and its Temperature Sensitivity

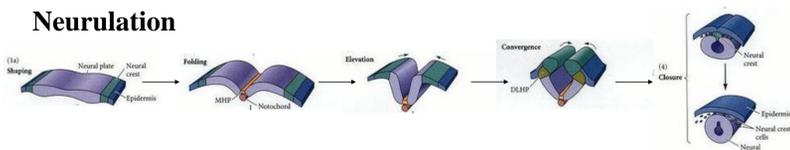
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## Abstract

Nodal signals are required in early embryonic development to pattern left-right asymmetry, to develop germ layers, especially mesoderm and ectoderm, and to develop the nervous system of vertebrates. This research studied on the temperature sensitivity of the one-eyed pinhead connected to squint (*sqt*) and cyclop (*cyc*) in TGFβ super signaling pathway. Half embryos from each batch of *oep<sup>m134</sup>* mutants were incubated in either 28.5C or 34C. The penetrance of *oep<sup>m134</sup>* was analyzed by staining pineal glands through in-situ hybridization. Higher percent of elongated and divided neural tubes was found in embryos incubated in 34C than that in 28.5C. The hypothesis was supported that the penetrance of *oep<sup>m134</sup>* gene expression was temperature dependent.

## Introduction

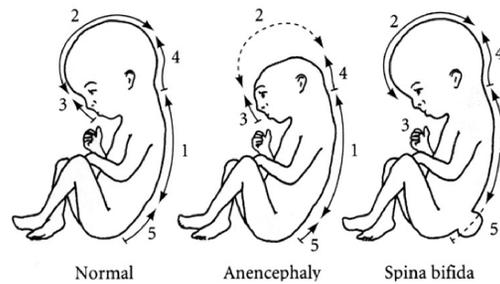
### Neurulation



Smith and Schoenwolf G, Neurosci 1997

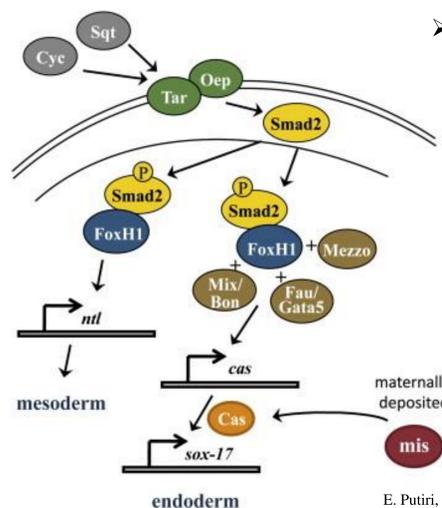
Neurulation is the mechanisms to form a neural tube, which later develops to nervous system of vertebrates.

### Birth defects caused by the failure to close neural tube properly



Neurosurg Focus @ 2004 American Association of Neurological Surgeons

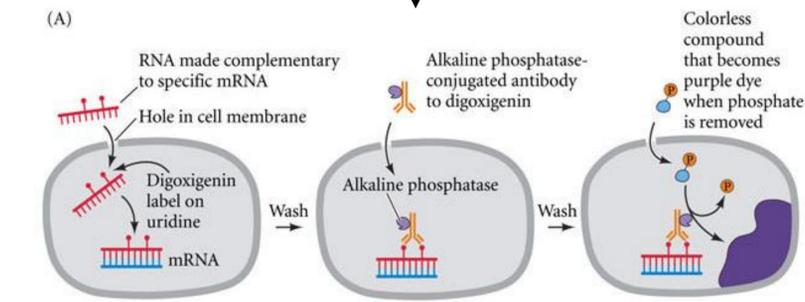
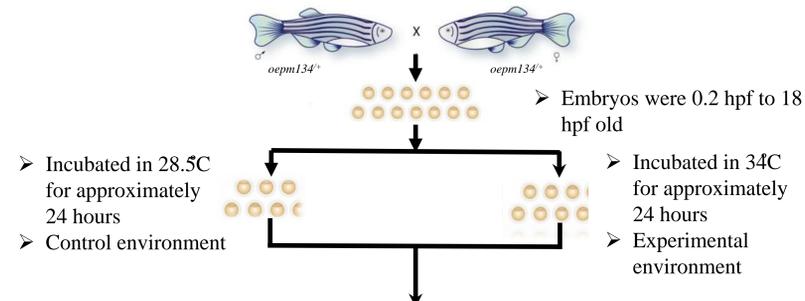
### Nodal Signaling Pathway



➤ One eye pinhead (*oep*) works with Nodals: cyclop (*cyc*) and squint (*sqt*)

E. Putiri, F. Pelegri, Developmental Biology 2011

## Methods



Source: S. Gilbert, Developmental Biology, 2010

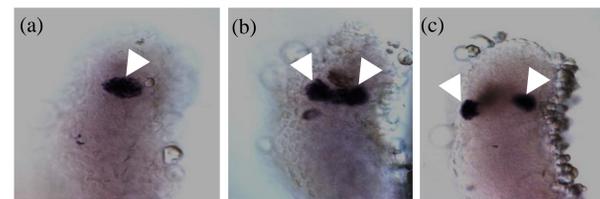
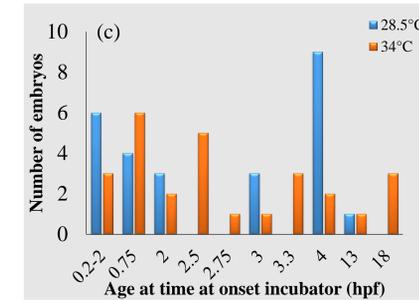
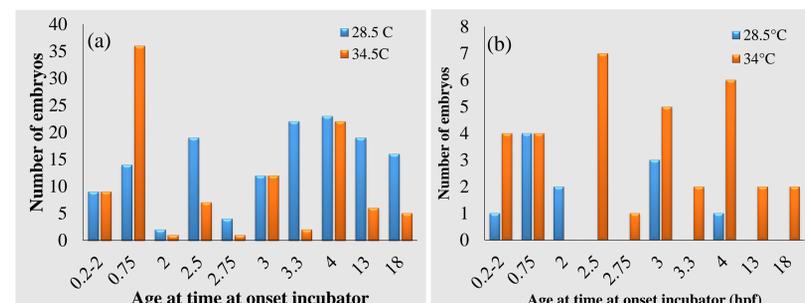


Figure 1 (a-c): Dorsal view of pineal glands in *oep<sup>m134</sup>* mutants

- pineal glands locate at the midline of the brain
- embryos with the failure to close neural tube had either elongated or divided pineal glands as shown in figure 1 (a-c).

## Result



### Combined Data

Temperature	Morphology		
	Closed	Open	
	Round	Elongated	Divided
28.5C	79%	6%	15%
34C	63%	20%	17%

- Incubating embryos at 34C stress enough to produce heat shock proteins.
- Graph (a) represents closed neural tube
- Graphs (b) elongated and (c) divided

## Discussion

- When embryos were incubated in 34C, heat-shock proteins, were turned on as a homeostatic response (Krone et al., 1997).
- Some heat-shock proteins have constitutive ability to turn on up-regulation of gene transcription.
- One-eyed pinhead could also be constitutively turned on and affect the entire TGFβ signaling pathway.
- As mentioned in introduction, one-eyed pinhead worked with squint nodals, which had been identified as temperature sensitive (Pei, 2007).
- The penetrance of one-eye pinhead *oep<sup>m134</sup>* mutants would be varied under different temperatures.
- In comparison of percentages in combined data, higher penetrance of open neural tubes were found.
- The percentages of elongated (20%) and divided neural tubes (17%) were significantly higher in 34C than that of open neural tubes (6% and 14%) in 28.5C.
- The percent of closed neural tube was decreased from 79% in 28.5C to 63% in 34C. The data suggested that the higher the temperature, the more abnormalities occurred due to the constitutive effect of heat-shock proteins.
- The hypothesis was supported that the penetrance of one-eye pinhead (*oep*) gene expression was temperature-sensitive.
- This experiment solved the question of TGFβ signaling pathway and its temperature sensitivity.

## Conclusion

- The penetrance of one-eyed pinhead (*oep*) mutants depends on the temperature.
- Since squint and one-eyed pinhead are temperature sensitive, the whole TGFβ super signaling pathway is temperature sensitive.

## Future Directions

- Experiment on effects of cold-shock and its related proteins
- The effective time of temperature sensitiveness

## Acknowledgement

Krone P, Sass J, Lele Z, Heat shock protein gene expression during embryonic development of the zebrafish, *Cell and Molecular Life Science*, 1997, 53:122-129.  
Pei W, William PH, Clark MD, Stemple DL, Feldman B: Environmental and genetic modifiers of squint penetrance during zebrafish embryogenesis. *Developmental Biology* 2007, 308(2):368-378  
Smith J L, Schoenwolf G C. Neurulation: Coming to closure. *Trends Neurosci*. 1997;11:510-517.  
Jennifer Liang and her lab groups