

We are walking and standing with parts of our bodies which could have been used for thinking had they developed in another part of the embryo.

Hans Spemann, 1943

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Reading from  
Chapter 3 - types of cell specification  
Chapter 6 - cell-cell signaling (molecules, pathways)  
Chapter 10 - amphibian axis formation

2nd Hourly Exam - Friday, October 31

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**TABLE 3.3** Modes of cell type specification and their characteristics

<b>I. Autonomous specification</b>	<b>Autonomous</b>
Characteristic of most invertebrates. Specification by differential acquisition of certain cytoplasmic molecules present in the egg. Invariant cleavages produce the same lineages in each embryo of the species. Blastomere fates are generally invariant. Cell type specification precedes any large-scale embryonic cell migration. Produces "mosaic" development: cells cannot change fate if a blastomere is lost.	
<b>II. Conditional specification</b>	<b>Conditional</b>
Characteristic of all vertebrates and few invertebrates. Specification by interactions between cells. Relative positions are important. Variable cleavages produce no invariant fate assignments to cells. Massive cell rearrangements and migrations precede or accompany specification. Capacity for "regulative" development: allows cells to acquire different functions.	
<b>III. Syncytial specification</b>	<b>Syncytial</b>
Characteristic of most insect classes. Specification of body regions by interactions between cytoplasmic regions prior to cellularization of the blastoderm. Variable cleavage produces no rigid cell fates for particular nuclei. After cellularization, conditional specification is most often seen.	

Source: After Davidson 1991.

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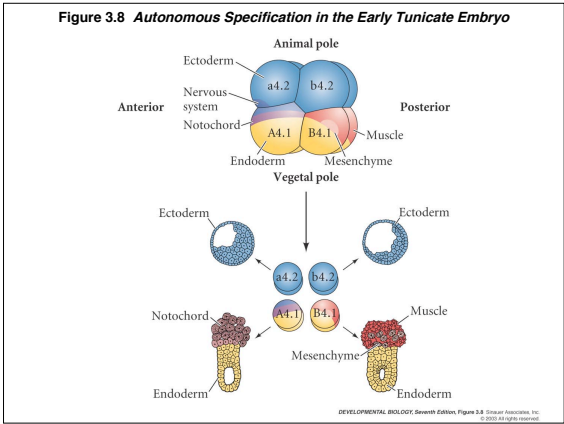
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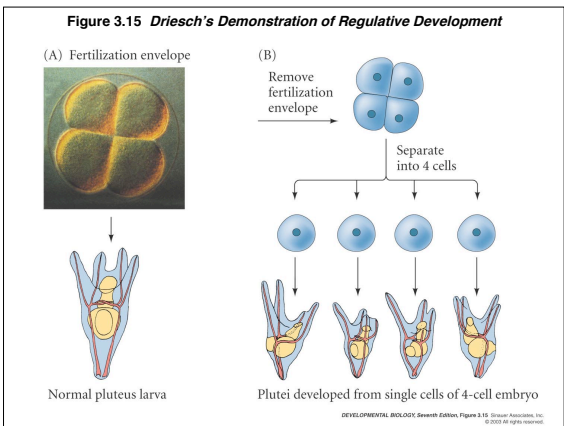
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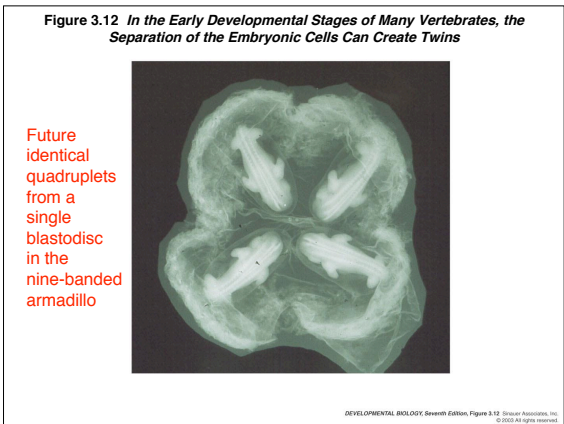
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**Hans Spemann & Ross Harrison**




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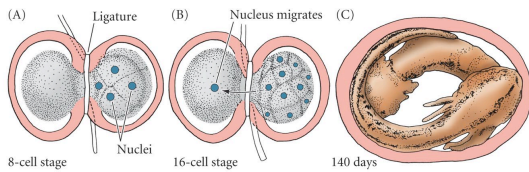
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**Figure 10.18 Spemann's Demonstration of Nuclear Equivalence in Newt Cleavage**



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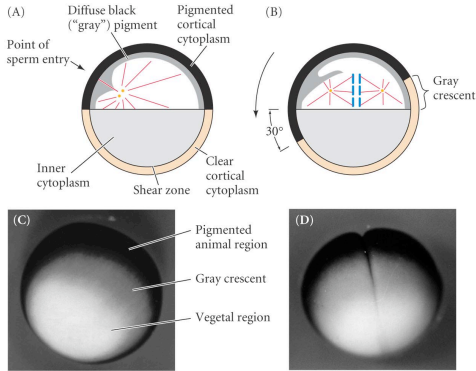
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**Figure 7.33 Reorganization of Cytoplasm in the Newly Fertilized Frog Egg**



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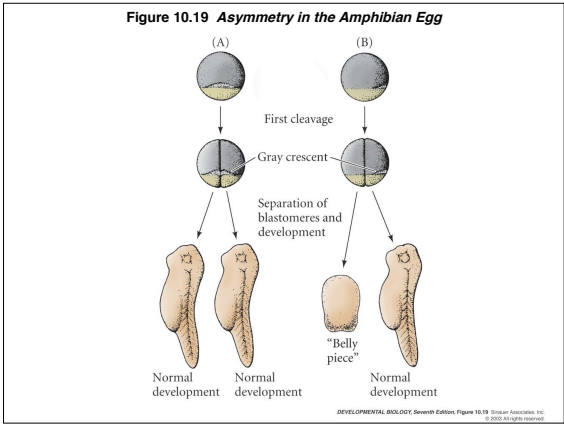
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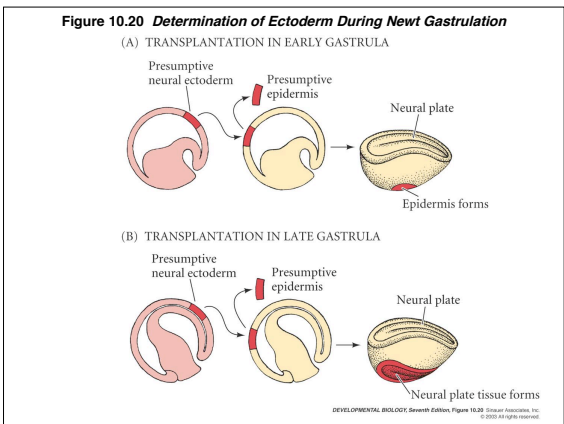
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**TABLE 10.1 Results of tissue transplantation during early- and late-gastrula stages in the newt**

Donor region	Host region	Differentiation of donor tissue	Conclusion
<b>EARLY GASTRULA</b>			
Prospective neurons	Prospective epidermis	Epidermis	Dependent (conditional) development
Prospective epidermis	Prospective neurons	Neurons	Dependent (conditional) development
<b>LATE GASTRULA</b>			
Prospective neurons	Prospective epidermis	Neurons	Independent (autonomous) development (determined)
Prospective epidermis	Prospective neurons	Epidermis	Independent (autonomous) development (determined)

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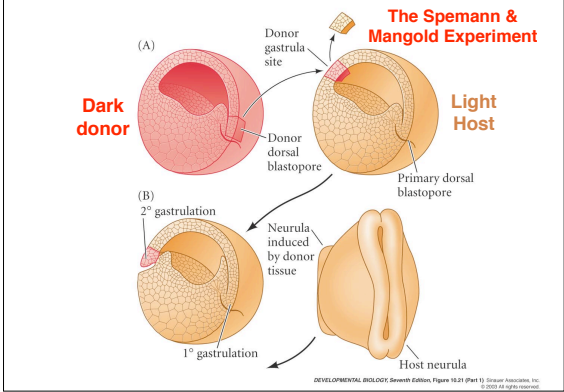
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Figure 10.21(1) Organization of a Secondary Axis by Dorsal Blastopore Lip Tissue




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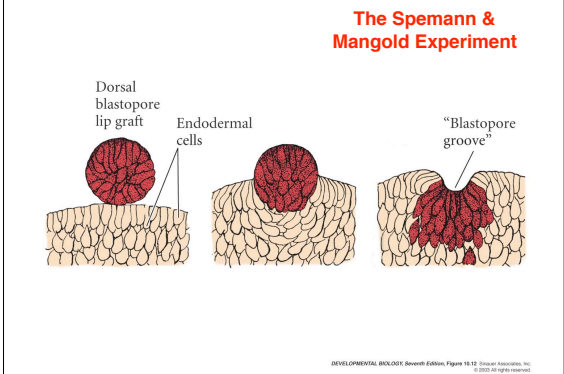
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Figure 10.12 Graft of Cells From Dorsal Marginal Zone of a Salamander Embryo Sinks into a Layer of Endodermal Cells and forms a Blastopore-like Groove




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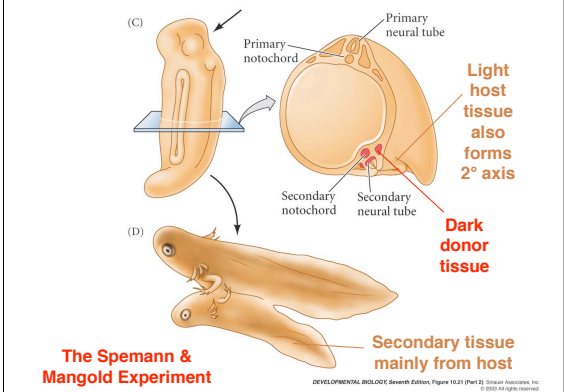
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Figure 10.21(2) Organization of a Secondary Axis by Dorsal Blastopore Lip Tissue




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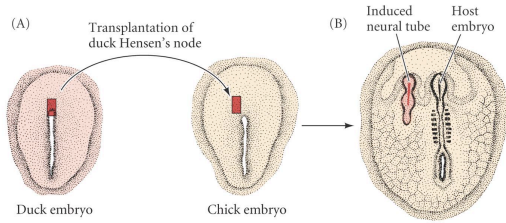
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Figure 11.20(1) Induction of a New Embryo by Transplantation of Hensen's Node



Hensen's node acts similarly to dorsal blastopore lip

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**The field of "Chemical Embryology" was premature and therefore a dismal failure**

Discovery of the "Organizer" set in motion a search for the substances that caused "primary induction." (Ross Harrison - "...the new Yukon to which eager miners were now rushing to dig for gold around the blastopore")

Researchers found that many tissues and substances, natural and artificial, could cause ectoderm to form nervous system ("primary induction").

Some 'inducers' of neural ectoderm:

- |                    |               |                         |
|--------------------|---------------|-------------------------|
| fixed dorsal lip   | fireplace ash | boiled guinea pig liver |
| methylene blue dye | ground glass  | turpentine              |

The discovery of organizer molecules could only come with the advent of powerful molecular biological and protein biochemistry techniques of the last 15-20 years.

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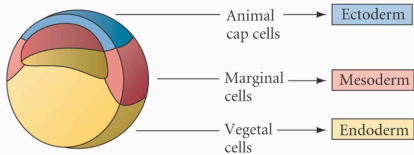
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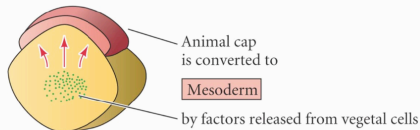
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Figure 10.22(1) Summary of Experiments by Nieuwkoop and by Nakamura and Takasaki, Showing Mesodermal Induction by Vegetal Endoderm

(A) Dissected blastula fragments give rise to different tissue in culture



(B) Animal and vegetal fragments give rise to mesoderm



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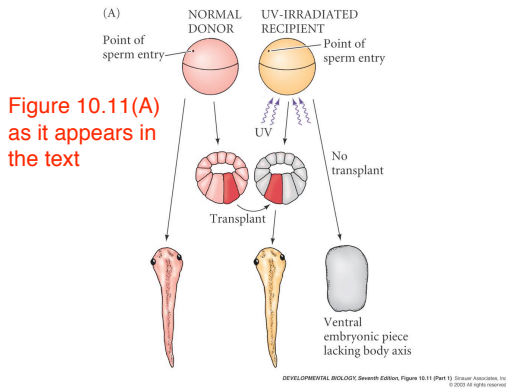
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**Figure 10.11(1) Transplantation Experiments on 64-cell Amphibian Embryos**




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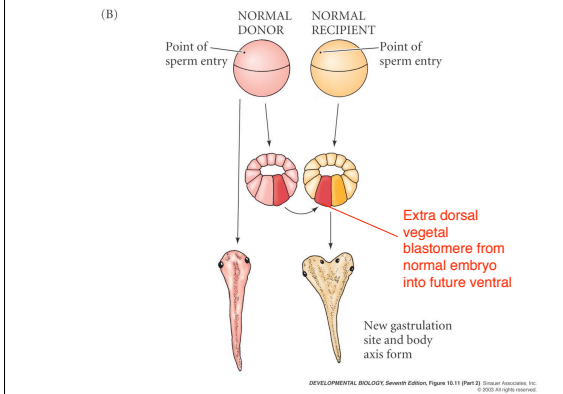
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**Figure 10.11(2) Transplantation Experiments on 64-cell Amphibian Embryos**




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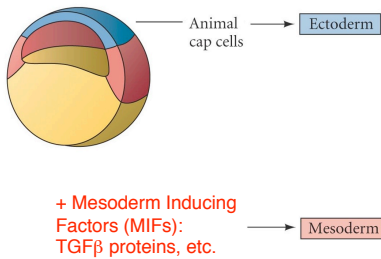
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**The Animal Cap Assay used to identify Mesoderm Inducing Factors**

**The Animal Cap Assay**




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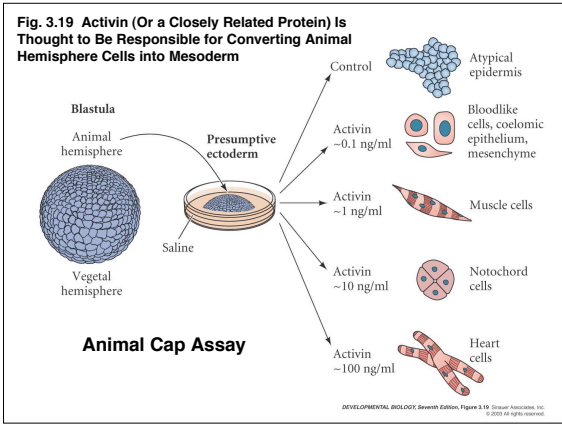
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**Fig. 3.19 Activin (Or a Closely Related Protein) Is Thought to Be Responsible for Converting Animal Hemisphere Cells into Mesoderm**




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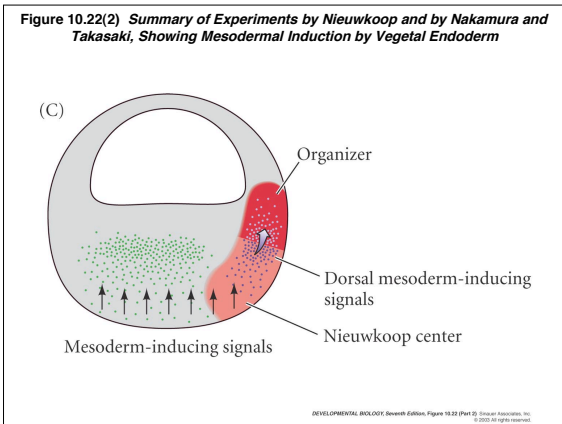
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**Figure 10.22(2) Summary of Experiments by Nieuwkoop and by Nakamura and Takasaki, Showing Mesodermal Induction by Vegetal Endoderm**




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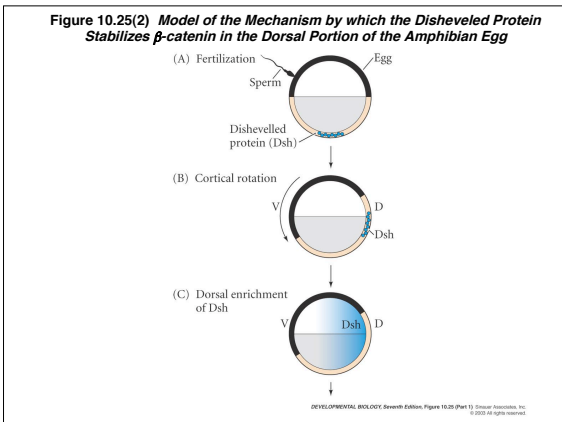
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**Figure 10.25(2) Model of the Mechanism by which the Dishevelled Protein Stabilizes  $\beta$ -catenin in the Dorsal Portion of the Amphibian Egg**




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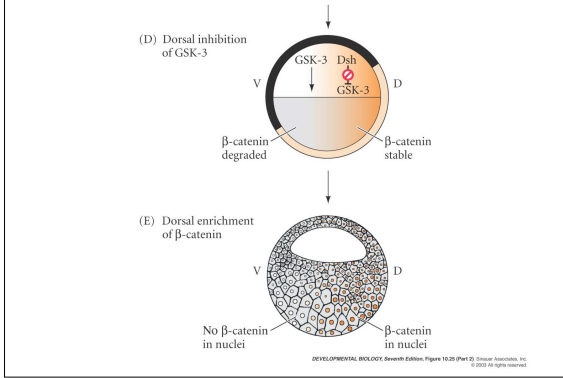
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**Figure 10.25(2) Model of the Mechanism by which the Disheveled Protein Stabilizes  $\beta$ -catenin in the Dorsal Portion of the Amphibian Egg**




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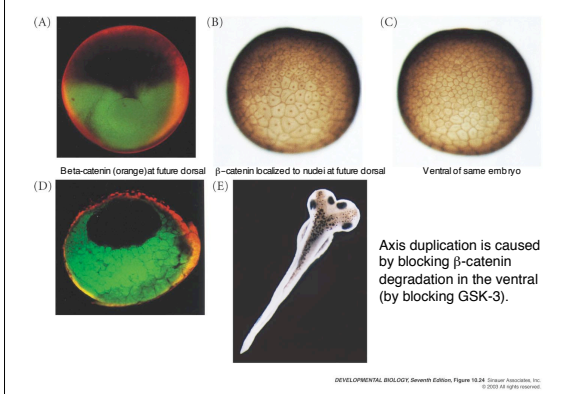
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**Fig. 10.24 The Role of Wnt Pathway Proteins in Dorsal-Ventral Axis Specification**




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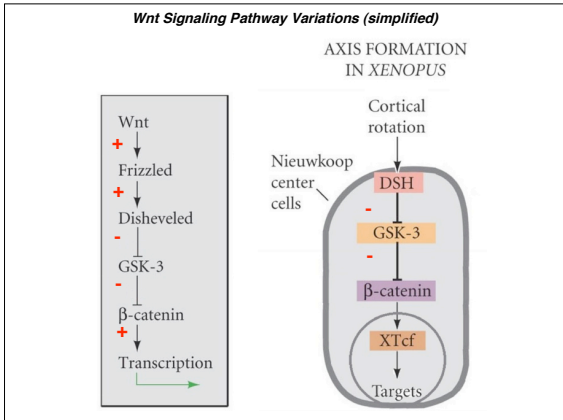
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**Wnt Signaling Pathway Variations (simplified)**




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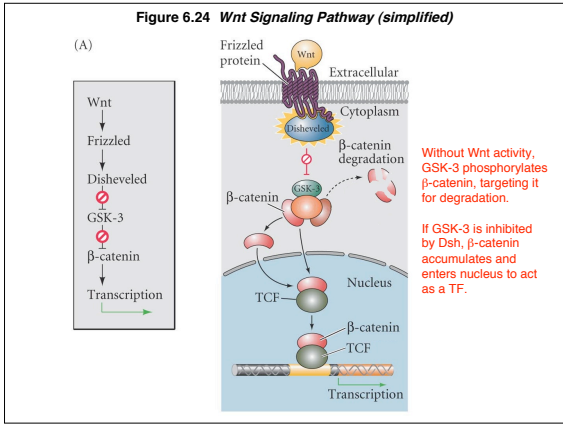
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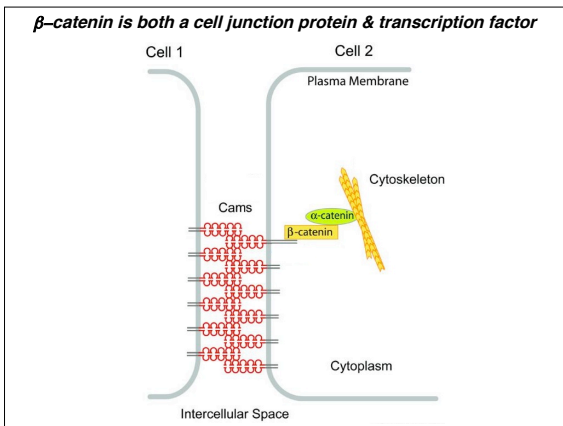
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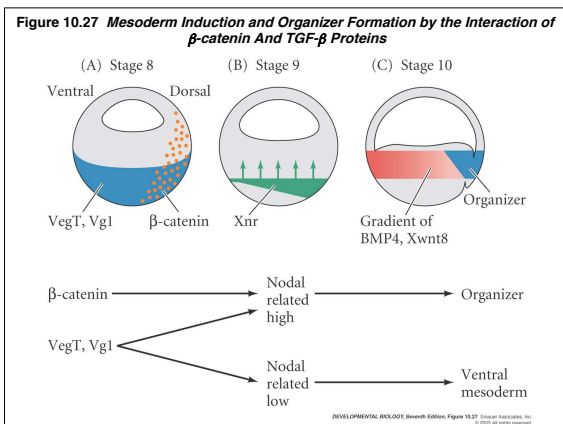
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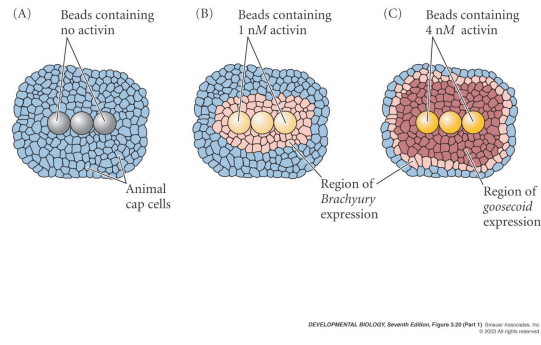
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**Figure 3.20(1) A Gradient of Activin Causes Different Gene Expression in *Xenopus* Animal Cap Cells**




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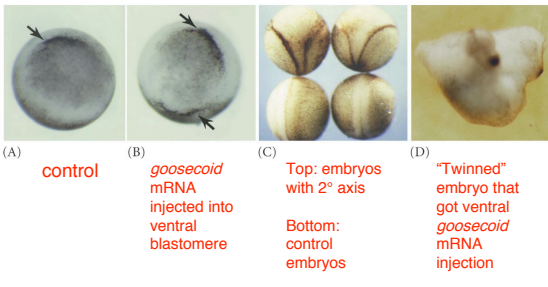
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**Figure 10.28 Ability of *goosecoid* mRNA to Induce a New Axis**




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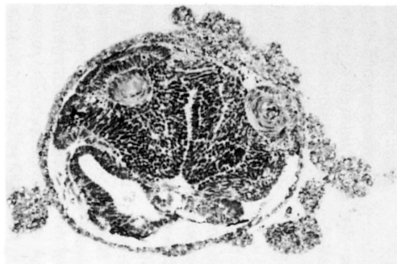
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**Fig. 10.29 Neural Structures induced in Presumptive Ectoderm by Newt Dorsal Lip Tissue, Separated From the Ectoderm by a Nucleopore Filter**



Dorsal lip secretes molecules that promote nervous system

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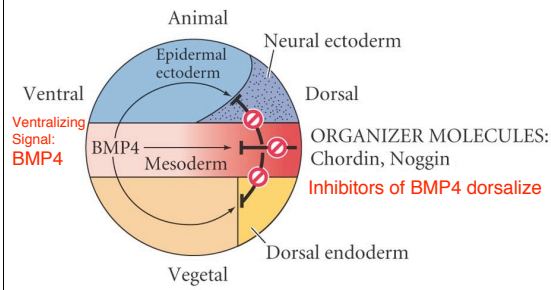
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**Figure 10.33 Model for action of the organizer**




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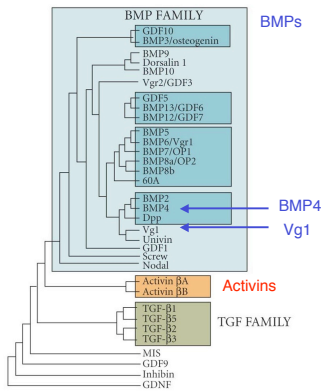
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**Figure 6.14 TGF- $\beta$  Superfamily Relationships**




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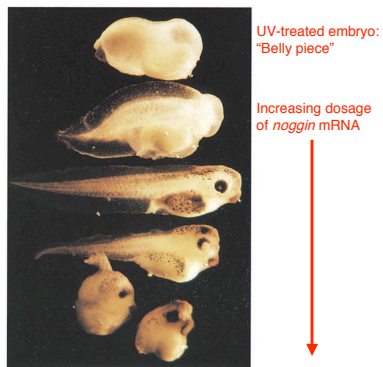
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**Figure 10.30 Rescue of Dorsal Structures by Noggin Protein**




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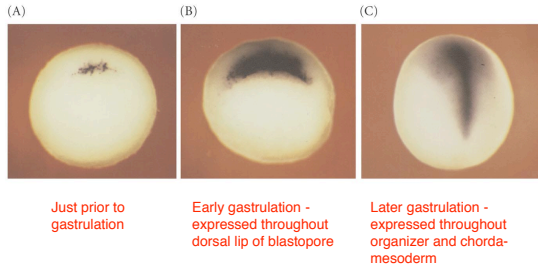
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**Figure 10.32 Localization of Chordin mRNA**



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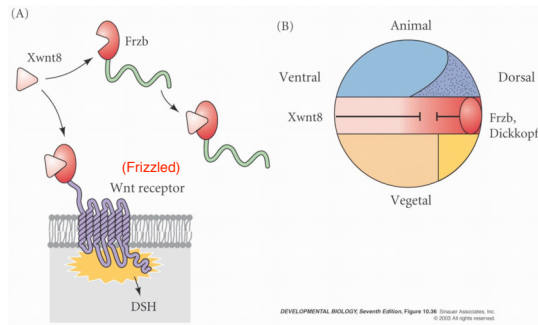
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**Figure 10.36 Xwnt8 Is Capable of Ventralizing the Mesoderm and Preventing Anterior Head Formation in the Ectoderm**



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**TABLE 10.2** Proteins expressed solely or almost exclusively in the organizer (partial list)

Nuclear proteins	Secreted proteins
<del>Xlim1</del>	Chordin
<del>Xnot</del>	<del>Dickkopf</del>
<del>Olig2</del>	<del>ADMP</del>
<del>XFD1</del>	Frzb
<del>XANT1</del>	Noggin
Goosecoid	<del>Follistatin</del>
<del>TTF3p</del>	Sonic hedgehog
	<del>Cerberus</del>
	Nodal-related proteins
	- (several)

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