47. Cleavage
   A. Draw the blastomeres following the upcoming cleavage.
   B. What is the likely yolk distribution of the egg?
   C. What sort of cleavage pattern will likely take place?
   D. Name an organism (species or phylum) that commonly shows each cleavage type

$$\text{isolecithal/mesolecithal}$$
$$\text{holoblastic}$$
$$\text{amphibian/mammal,}$$

$$\text{telolecithal}$$
$$\text{meroblastic}$$
$$\text{bird, fish}$$

$$\text{telolecithal}$$
$$\text{holoblastic}$$
$$\text{fish, reptile}$$

48. Fast block to polyspermy (sea urchin)
   A. label axes
   B. provide scale for axes
   C. label point of sperm-egg membrane fusion
   D. show region of polyspermy block
   E. show region of loss of polyspermy block

<table>
<thead>
<tr>
<th>membrane potential (mV)</th>
<th>polyspermy block</th>
<th>loss of polyspermy</th>
</tr>
</thead>
<tbody>
<tr>
<td>-80</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>+2</td>
<td></td>
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</tbody>
</table>

Time (min)
Short essay (answer any 5; use the back of the page for illustration if necessary; 10 points each)

41. Define the mid-blastula transition and describe the changes occurring in the embryo at that time.
MBT – point at which developmental control is transferred from maternal to zygotic.
- increased nucleocytoplasmic ratio
- cell cycle slows
- asynchronous cleavage
- motile blastomeres

42. Compare cleavage in chick and mammalian embryos. Use simple drawings to illustrate and label all relevant parts.

![Diagram of chick and mammalian embryos]

43. Explain the role of bindin in sea urchin development.
Bindin is a sperm protein located within the acrosome. The acrosome reaction exposes bindin to receptors on the vitelline envelope. Binding secures the sperm to the egg.
- bindin participates in species specificity
- bindin is very active evolutionarily

44. Describe clonal analysis.
Involves labeling an individual cell and following its progeny through development. Labeling can be accomplished either physically (e.g. injection of a fluorescent molecule) or by creating phenotypic mutants (e.g. X-ray induced somatic crossover).

45. Describe the role of MPF in controlling the cell cycle.
MPF = M-phase promoting factor (or Maturation promoting factor)
phosphorylated CDK (cyclin dependent kinase) binds cyclin form active MPF
MPF kinase activity initiates progression through mitosis
- also initiates release from meiotic arrest in oocytes

46. Describe the mechanisms during fertilization that help ensure species specificity.
Behavioral – synchronized spawning
Anatomical
Chemotactic – eggs produce a specific molecule that attracts sperm
Sperm/egg binding – specific egg and sperm ligand/receptor combinations
Acrosome reaction triggers – species-specific activators produced by eggs
29. During spermatogenesis, spermatid DNA is tightly condensed with unique histones.  __F__

30. Bat wings and insect wings are analogous but not homologous structures.  __T__

**Short answer** (one point per blank; some blanks may require multiple words)

31. When a cell’s potency equals its fate, the cell is said to be determined.

32. Experimental evidence shows that the cleavage pattern is controlled in part by the orientation of the mitotic spindle.

33. The sea urchin cortical reaction is triggered by calcium release from the endoplasmic reticulum.

34. In mammals, blastocyst formation is preceded by compaction, during which the inner and outer cell layers are formed.

35. A single cell transplanted into a different embryonic region does not develop according to its fate, while a multi-cell transplant to the same region develops in accord with its fate. The donor cells in this heterotopic transplantation demonstrated a strong community effect.

36. Spemann’s classic experiment demonstrating the effect of vertebrate neural tissue on lens formation is an example of embryonic induction.

37. To definitively that optic vesicle tissue is responsible for inducing the lens placode in vertebrates, it must be shown to be necessary and sufficient.

38. In lateral inhibition, equivalent cell types produce inhibitory signals that prevent neighboring cells from attaining the same fate.

39. The theory that gametes contain copies of adult forms, called preformation, was countered by the theory of epigenesis, which stated that organisms were newly formed during development.

40. The classic set of embryological experimental techniques practiced by Spemann and others include isolation, removal, and transplantation.
16. MPF stands for:
   a. **M-phase promoting factor**
   b. mitosis promoting factor
   c. meiosis promoting factor
   d. meiosis preventing factor

17. In Drosophila, a mature egg chamber will contain:
   a. 16 oocytes
   b. 1 oocyte, 3 nurse cells
   c. 1 oocyte, 3 polar bodies
   d. **1 oocyte, 15 nurse cells**

18. Mammalian sperm motility is probably most important to:
   a. transport the sperm from the cervix to the oviduct
   b. transport the sperm from the uterine horn to the ampulla of the oviduct
   c. **transport the sperm in the vicinity of the egg**
   d. none of the above

19. In eggs of many species, fertilization triggers:
   a. **calcium transients**
   b. lysosomal breakdown
   c. rapid transcriptional activity
   d. all of the above

20. The sea urchin sperm acrosomal process is constructed of:
   a. microtubules
   b. actomyosin
   c. lysophosphatase
   d. **none of the above**

**True/False** (one point each)

21. The acrosome reaction is triggered by the release of internal calcium stores. **F**

22. The cortical reaction is triggered by release of internal calcium stores. **T**

23. The potency of a region always includes its fate. **T**

24. A transplantation experiment can be heterotopic and heterochronic at the same time. **F**

25. Induction is a product of the interaction of non-equivalent cells. **T**

26. Operational criteria include such characteristics as morphology and biochemical functionality. **F**

27. *Ceanorhabditis elegans* demonstrates invariant cleavage and thus is an example of regulative development. **F**

28. In general, the determined state is stably passed on during mitosis. **T**
8. In humans meiotic arrest is broken:
   a. at birth
   b. at sexual maturity
   c. at ovulation
   d. at fertilization

9. The hyaline layer:
   a. is part of the zona pellucida
   b. requires peroxidases for formation
   c. triggers the acrosome reaction
   d. all of the above

10. Discoidal cleavage occurs in only:
    a. isolecithal eggs
    b. telolecithal eggs
    c. mesolecithal eggs
    d. disocolecithal eggs

11. Meroblastic cleavage is characteristic of:
    a. all animals
    b. placental mammals
    c. fish
    d. none of the above

12. In organisms with rotational cleavage:
    a. the first cleavage is equatorial, the second meridional
    b. the first cleavage is equatorial, the second is opposingal
    c. the first cleavage is meridional, the second is equatorial
    d. the first cleavage is meridional, the second is opposingal

13. Fate maps can be constructed using:
    a. fluorescent molecules
    b. pigmented cells
    c. transplantation experiments
    d. all of the above

14. Sperm contribute intact ________ to the embryo.
    a. nucleus and microtubules
    b. nucleus and centriole
    c. nucleus and centriole and ribosomes
    d. nucleus and centriole and ribosomes and microtubules

15. If a cell is totipotent, the following will be true:
    a. the cell is determined
    b. the cell’s fate map can be established with certainty
    c. the cell’s potency equals its fate
    d. none of the above
Multiple choice (one point each)

1. Primordial germ cells
   a. are immortal
   b. produce polar bodies
   c. are haploid
   d. are somatic stem cells

2. Compaction results in formation of a:
   a. blastocoel
   b. blastopore
   c. blastoderm
   d. blastocyst

3. The final products of mammalian oogenesis are:
   a. one primary oocyte and three polar bodies
   b. one primary oocyte and one polar body
   c. two primary oocytes and two polar bodies
   d. four primary oocytes

4. A fertilized sea urchin egg is surrounded by layers in the following order:
   a. hyaline layer, vitelline envelope, cumulus
   b. plasma membrane, vitelline envelope, follicular cells
   c. vitelline envelope, hyaline layer, granulosa
   d. plasma membrane, hyaline layer, vitelline envelope

5. The sea urchin sperm acrosome reaction
   a. occurs during sperm capacitation
   b. is triggered by estrogen
   c. is triggered by chemotactic agents released by eggs
   d. is triggered by egg jelly components

6. In the mammalian seminiferous tubule, mature sperm are located:
   a. closest to the outside wall
   b. closest to the inside luminal space
   c. embedded in the spermatogonia
   d. embedded in the Leydig cells

7. Human females have the most oocytes:
   a. at birth
   b. at sexual maturity
   c. prior to birth
   d. at the peak of reproductive potential