Unit 16 · Development of the Frog

ANSWER KEY · FOR TEACHERS

Full marks 31.5

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. amplexus
2. cone of reception
3. fertilization membrane
4. holoblastic
5. megameres
6. epiboly
7. archenteron
8. schizocoel

Each carries 0.5 mark. **K · 4**

2 Label the diagram

1. nephrotome
2. somatic layer
3. coelom (splanchnocoel)
4. splanchnic layer
5. gut (endoderm)

Each carries 0.5 mark. **K · 2.5**

3 Multiple choice

i. **b.** Ectodermal cells spread to cover the entire surface of the embryo. **K · 1**

In **epiboly** (Greek, "throwing over"), the small ectodermal cells of the animal half spread down over the yolky cells until they cover the whole embryo except the yolk plug.

ii. **b.** the vitelline membrane lifts off and becomes the fertilization membrane **U · 1**

The egg releases fluid under its vitelline membrane, which lifts off, thickens and becomes the **fertilization membrane**. Sperm lysins can't dissolve it, so only one sperm gets in (**monospermy**).

iii. **b.** the third furrow forms above the equator, because the yolk in the vegetal half pushes the spindles up **U · 1**

The heavy yolk of the vegetal half pushes the spindles of the third division towards the animal pole, so the latitudinal furrow forms **above the equator**: four small cells above, four large ones below. The large yolky cells then divide **more slowly**, not faster.

iv. **b.** The mesoderm would fail to develop, and the embryo would have no coelom. **A · 1**

A frog's coelom forms by the **splitting of the mesoderm**. With no mesoderm, there is nothing to split, so there would be **no coelom** (and no notochord, muscles, blood or kidneys either).

v. **c.** the sclerotome **K · 1**

The **sclerotome** (Greek *skleros*, "hard") forms the vertebrae round the notochord. The dermatome makes the dermis, the myotome the muscles, and the nephrotome, which is not part of a somite, the kidney tubules.

4 Short answers

a. **K · 2**

MARKING SCHEME

✓ Rapid mitotic divisions of the zygote into blastomeres.

✓ The cells don't grow between divisions, so the size stays the same as the cells get smaller.

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b. ANSWER U · 2

Any two: it forms a **diploid zygote** (2n = 26) that develops into the embryo; it brings in the **centriole** for the zygote's divisions; it **prevents polyspermy** through the fertilization membrane; it makes the egg **complete its second maturation division**; it **brings variation**, combining chromosomes from two parents.

MARKING SCHEME

- ✓ A first correct significance (e.g. restores the diploid number in the zygote).
- ✓ A second (e.g. brings in the centriole, prevents polyspermy, or brings variation).

c. MARKING SCHEME A · 2

- ✓ A second body axis (neural tube, notochord, somites) formed, mostly of the host's cells.
- ✓ The dorsal lip induces other cells: it is the organizer.

d. MARKING SCHEME U · 3

- ✓ A hollow ball with a fluid-filled, dome-shaped blastocoel in the animal half (coeloblastula).
- ✓ Roof of small micromeres, floor of large yolky megameres.
- ✓ The blastocoel keeps roof and floor apart and gives room for cell movement in gastrulation.

5 Long answers

a. ANSWER U · 4

Gastrulation is the stage in which the cells of the blastula move into the three germ layers, by morphogenetic movements; the blastula becomes a **gastrula**.

1. **Epiboly:** the micromeres divide fast and spread down over the megameres until they cover the embryo except the **yolk plug**.
2. **Emboly (invagination):** below the gray crescent, cells sink in to form the crescent-shaped **blastopore**, which deepens into the **archenteron** (the future gut); the blastocoel shrinks and disappears.
3. **Involution:** marginal zone cells roll in over the **lips of the blastopore**: over the dorsal lip they form the **chorda-mesoderm**, over the others the rest of the mesoderm. The lips close in round the yolk plug.
4. **Rotation:** the embryo turns about **90**° inside its fertilization membrane, the blastopore at the back.

At the end there are three germ layers: ectoderm, mesoderm and endoderm.

MARKING SCHEME

- ✓ Definition: cells of the blastula move into the three germ layers.
- ✓ Epiboly: micromeres spread over the megameres, leaving the yolk plug.
- ✓ Emboly: blastopore and archenteron form, the blastocoel disappears.
- ✓ Involution over the lips (chorda-mesoderm and mesoderm), and rotation of about 90°.

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b. ANSWER A · 4

The **ectoderm** (the brain and spinal cord from the neural plate; nerves and ganglia from the neural crest).

1. The dorsal ectoderm thickens into the **neural plate**, induced by the chorda-mesoderm beneath.
2. A **neural groove** appears along its middle, and its edges rise as **neural folds**.
3. The groove deepens; the folds grow towards each other, **meet and fuse**, and the groove becomes a closed **neural tube**, which sinks under the ectoderm; the **neural crest** separates between them.
4. The neuropores close; the front of the tube becomes the **brain**, the rest the **spinal cord**, and its cavity, the **neurocoel**, the ventricles and central canal.

MARKING SCHEME

✓ Ectoderm; the neural plate forms, induced by the chorda-mesoderm.
✓ Neural groove and neural folds.
✓ The folds meet and fuse into the neural tube, which sinks below the ectoderm.
✓ Brain in front, spinal cord behind; the neurocoel becomes the ventricles and central canal.

6 Think

ANSWER HA · 3

The **animal pole** region marks the future **head (anterior)** end and the **vegetal pole** region the **posterior** end: this axis is there before fertilization.
After the sperm enters, the cortex turns and the **gray crescent** appears opposite the entry point: it marks the **dorsal side** (where the dorsal lip of the blastopore forms), so the egg becomes **bilaterally symmetrical**.
The **first cleavage** usually passes through the middle of the gray crescent, so its two cells become roughly the **left and right** halves of the tadpole.

MARKING SCHEME

✓ Animal pole region: head end; vegetal pole region: posterior end.
✓ The gray crescent, opposite the sperm's entry, marks the dorsal side and makes the egg bilateral.
✓ The first cleavage through the gray crescent separates left from right.

7 Activity: Frog eggs to tadpoles

(not marked)

WHAT STUDENTS SHOULD FIND

On the first day, round **black-and-white** eggs, black side up; over the first hours they divide into a ball of cells, smaller dark cells above, larger pale ones below. By the second or third day each egg has **stretched** into a curved body with a head and a tail end. Within a week or two, small **tadpoles** wriggle out of the jelly. The top cells are smaller because the **yolk** in the vegetal half slows division and pushes the furrows up (unequal holoblastic cleavage).

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	10.5	11	7	3	**31.5**

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