Unit 22 · Protista

ANSWER KEY · FOR TEACHERS

Full marks 36

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. plankton
2. frustule
3. paramylon
4. cyclosis
5. cytopyge
6. metachronal
7. dimorphism
8. amphimixis

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. oral groove
2. micronucleus
3. cytostome
4. caudal tuft
5. trichocysts
6. macronucleus
7. posterior contractile vacuole
8. radial canals

K · 4

Each carries 0.5 mark.

3 Multiple choice

i. **c.** *Noctiluca* — K · 1

Noctiluca, a dinoflagellate (Pyrrophyta), makes its own light; it is the "sea sparkle" that makes waves glow at night. *Physarum* and *Dictyostelium* are slime molds; *Leishmania* is a parasitic flagellate.

ii. **b.** 6–10 — K · 1

Each contractile vacuole has about **six to ten** radial (radiating) canals.

iii. **c.** Sporozoa — U · 1

These are the **Sporozoa**, such as *Plasmodium* and *Monocystis*. The other three classes are named for the way they move: flagella, pseudopodia and cilia.

iv. **c.** the micronucleus by mitosis, the macronucleus by amitosis — U · 1

The small **micronucleus** divides exactly, by **mitosis**, with a spindle. The big **macronucleus**, with its hundreds of copies of each gene, simply pinches in two by **amitosis**. Meiosis happens only in conjugation (and autogamy).

v. **c.** It is near the cytopharynx, where more water enters with the food. — A · 1

Each new food vacuole brings a gulp of water into the cell at the **cytopharynx**, near the back. The **posterior** vacuole, being closest, has more water to remove.

4 Very short answers

a. MARKING SCHEME — K · 1

✓ Ernst Haeckel, 1866.

b. MARKING SCHEME — K · 1

✓ *Leishmania donovani*, spread by the sandfly.

c. MARKING SCHEME — U · 1

✓ Autotrophic in light and heterotrophic in the dark.

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5 Short answers

a. MARKING SCHEME — U · 2

- ✓ Plasmodial: one multinucleate mass, e.g. *Physarum*.
- ✓ Cellular: single amoebae that keep their membranes when they gather, e.g. *Dictyostelium*.

b. MARKING SCHEME — A · 2

- ✓ They would contract less often or stop.
- ✓ Little water enters by osmosis when the water outside is about as salty as the cytoplasm.

c. ANSWER — HA · 2

Without its **micronucleus** it goes on living, feeding and even dividing by fission for a time, because the macronucleus runs its daily life; but it can't conjugate, so the line can't be renewed and in the end dies out. Without its **macronucleus** it soon dies.

MARKING SCHEME

- ✓ Without the micronucleus it lives and divides for a time but can't conjugate, so the line dies out.
- ✓ Without the macronucleus it soon dies.

d. MARKING SCHEME — U · 3

- ✓ Rod-shaped organelles in the ectoplasm, at right angles to the surface; a shaft of packed protein with a capped tip.
- ✓ A stimulus lets calcium in; the cap opens and the protein swells, shooting out a striated thread with the spike at its end.
- ✓ Functions: anchoring, and defense against predators.

6 Long answers

a. ANSWER — U · 4

Macronucleus	Micronucleus
large and bean-shaped (kidney-shaped)	small and spherical
one per cell	one per cell in *P. caudatum* (more in some species)
many copies of the genes (polyploid)	diploid (two sets of chromosomes)
controls metabolism, the daily life of the cell: the somatic or vegetative nucleus	controls reproduction: the generative nucleus
divides by amitosis in binary fission	divides by mitosis in binary fission, and by meiosis in conjugation
breaks up and disappears in conjugation; a new one is made	survives conjugation; its products are exchanged and fuse
the cell can't live without it	the cell can live without it for a time, but can't conjugate

MARKING SCHEME

- ✓ Macronucleus large and bean-shaped, micronucleus small and spherical.
- ✓ Macronucleus has many copies of the genes; micronucleus is diploid.
- ✓ Macronucleus controls metabolism (vegetative); micronucleus controls reproduction (generative).
- ✓ Macronucleus divides by amitosis and breaks up in conjugation; micronucleus divides by mitosis, and by meiosis in conjugation.

b. ANSWER

Conjugation: a temporary union of two Paramecia of different mating types to exchange micronuclei.

1. Two individuals of different mating types join at their oral grooves; they stop feeding, and a protoplasmic bridge forms between them (**conjugants**).
2. In each, the macronucleus breaks up; the micronucleus divides by **meiosis** into four haploid nuclei, three of which degenerate.

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3. The remaining one divides by mitosis into a small **migratory** and a large **stationary** pronucleus. U · 4
4. The migratory pronuclei are **exchanged** across the bridge, and each fuses with the stationary pronucleus of the other: a diploid **zygote nucleus** (synkaryon) forms in each (amphimixis).
5. The two separate (**exconjugants**) after 12–48 hours.
6. In each, the zygote nucleus divides three times by mitosis into **eight** nuclei: four become macronuclei, four micronuclei, of which three degenerate.
7. The remaining micronucleus divides and the cell divides twice by binary fission, giving **four** daughters, each with one macronucleus and one micronucleus.
8. So the pair gives **eight** genetically new daughters.

(Diagram as in the figure in the book.)

MARKING SCHEME

- ✓ Conjugation: two of different mating types join at the oral grooves; a protoplasmic bridge forms.
- ✓ Macronucleus breaks up; micronucleus divides by meiosis, three of four degenerate, the last gives a migratory and a stationary pronucleus.
- ✓ Migratory pronuclei are exchanged and fuse with the stationary ones: a zygote nucleus (synkaryon); the exconjugants separate.
- ✓ The zygote nucleus gives eight nuclei (four macro, four micro, three degenerate); two fissions give four daughters each, eight from the pair.

7 Think

ANSWER HA · 3

In binary fission the macronucleus only pinches in two by amitosis, generation after generation, and the line grows **weak** and divides more slowly. It needs **conjugation** with a *Paramecium* of a **different mating type** (or autogamy), which replaces the old macronucleus with a new one made from the zygote nucleus and **rejuvenates** the line. The offspring of binary fission are a **clone**, identical to the parent; after conjugation, meiosis and the exchange of pronuclei give each daughter a **new combination** of genes from two parents.

MARKING SCHEME

- ✓ Long runs of fission (macronucleus by amitosis) weaken the line.
- ✓ It needs conjugation with a partner of a different mating type, which renews the macronucleus (rejuvenation).
- ✓ Fission gives an identical clone; conjugation gives new combinations of genes (variation).

8 Activity: Fission and conjugation compared (Activity 8.3)

(not marked)

WHAT STUDENTS SHOULD FIND

	Transverse binary fission	Conjugation
asexual or sexual?	asexual	sexual (exchange of nuclei)
how many parents?	one	two, of different mating types
in which conditions?	favorable: food, suitable temperature	unfavorable: starvation, weakness, cold, darkness
how the micronucleus divides	mitosis only	meiosis, then mitosis
what happens to the macronucleus	divides by amitosis	breaks up and is replaced
daughters from one cell or pair	two, identical (a clone)	eight from a pair, genetically different

Conjugation brings variation; binary fission gives identical copies.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	12	16	3	5	**36**

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