

Past-paper walk-through

Environmental Effects on Phenotype ■ 5.5

eXercise

Questions in this set

- 2018 Q7

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 7

2018 ■ Q7

In the tongue sole fish (*Cynoglossus semilaevis**), sex is determined by a combination of genetics and environmental temperature. Genetically male fish have two Z chromosomes (ZZ), and genetically female fish have one Z chromosome and one W chromosome (ZW). When fish are raised at 22°C, ZZ fish develop into phenotypic males and ZW fish develop into phenotypic females. However, when fish are raised at 28°C, the Z chromosome is modified (denoted as Z*). Z*W individuals develop as phenotypic males that are fertile and can pass on the Z* chromosome to their offspring even when the offspring are raised at 22°C. A cross between a ZW female and a Z*Z male is shown in the Punnett square below.

×	Z	W
	Z*	Z*Z
	Z*W	
	Z	ZZ
	ZW	

(a) Predict the percent of phenotypic males among the F₁ offspring of the cross shown in the Punnett square if the offspring are raised at 22°C.

Question 7

(b) At least one Z or Z* chromosome is necessary for survival of the fish. A researcher crossed two fish and observed a 2:1 ratio of males to females among the offspring. Based on the information, **identify** the genotype of the male parent in the cross. **Describe** ONE fitness cost to the female of mating with this particular male.

Question 7

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	Z	W
Z^*	$Z^* Z$	$Z^* W$
Z	ZZ	ZW

Solution 7

(a)

Mark scheme

- 75% (1 pt). Of the four offspring genotypes in the Punnett square (Z^*Z , Z^*W , ZZ , ZW), three develop as phenotypic males: Z^*Z and ZZ (both carry two Z-type chromosomes, no W), and Z^*W (because the Z^* chromosome causes male development regardless of temperature — Z^*W individuals are phenotypic males even when raised at 22°C). Only ZW develops as a phenotypic female. So 3 of 4 = 75% phenotypic males.

Solution 7

(b) Mark scheme

- Genotype of the male parent: Z^*W (1 pt). A Z^*W male crossed with a normal ZW female produces offspring Z^*Z , Z^*W , ZW , and WW in a 1:1:1:1 ratio; since at least one Z or Z^* chromosome is necessary for survival, the WW offspring (1/4 of the total) die, leaving Z^*Z (male), Z^*W (male), and ZW (female) survivors in a 2:1 male:female ratio, matching the observed data. Fitness cost to the female of mating with this Z^*W male (1 pt, any one of): fewer offspring overall will develop/survive (since 1/4 of all offspring — the WW genotype — are predicted to die); or some of her offspring (all of her male offspring) will carry the Z^* chromosome, which may carry further costs for future generations.