7. 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 | Z Z | Z W |

(a) **Predict** the percent of phenotypic males among the $F_1$ offspring of the cross shown in the Punnett square if the offspring are raised at 22°C.

(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.

# AP® BIOLOGY
# 2018 SCORING GUIDELINES

## Question 7

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 | Z Z | Z W |

(a) **Predict** the percent of phenotypic males among the $F_1$ offspring of the cross shown in the Punnett square if the offspring are raised at 22°C.

**Prediction (1 point)**
75%

(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.

**Identification (1 point)**
Z* W

**Description (1 point)**
- Fewer offspring will develop/survive.
- 1/4 of the offspring are predicted to die.
- Some of her offspring will have the Z* chromosome/all of her male offspring will have a Z* chromosome.