Name: _____ SSN (last 4 digits): _____

UNIVERSITY OF HOUSTON

FALL SEMESTER, 2004

BIOLOGY

BIOL4397 — Evolution of Development

NOTE: The maximum score is **100 points**. An incorrect, non-blank answer to a true/false or multiple choice question will incur a deduction of 25% of its score. Time allowed: **45 minutes**. You are advised to spend 20 minutes on questions 1–5 and 25 minutes on question 6.

1. Which of the following statements best describes Haeckel's Biogenetic Law? **[3 points]**

(a) Development determines the course of evolution. [ ]

(b) Early developmental stages of related organisms are more similar to each other than are later developmental stages. [ ]

(c) The development of every organism recapitulates major events from its evolutionary history. [ ]

(d) Evolution occurs by the natural selection of developmental programs. [ ]

2. Evaluate the following statements about the field of evolutionary developmental biology (EDB): **[2 points each]**

(a) The resurgence of interest in EDB during the 1980s was partly motivated by the discovery that several important developmental mechanisms are conserved among distantly related groups of organisms. True [ ] False [ ]

(b) Scientists such as von Baer, Haeckel and Waddington were not interested in any of the questions studied in modern EDB. True [ ] False [ ]

(c) The relative lack of progress in EDB from the 1940s to the 1970s was partly caused by the fact that Darwin was not interested in developmental biology. True [ ] False [ ]

(d) Traditionally, evolutionary biologists and developmental biologists view the phenomenon of variation in fundamentally different ways . True [ ] False [ ]

(e) EDB aims to understand how developmental mechanisms affect the course of evolution. True [ ] False [ ]

(f) EDB resulted from the coming together of evolution, systematics, genetics and paleontology during the 1930s. True [ ] False [ ]

3. In the fruit fly *D. melanogaster*, the number of bristles on the scutellum is essentially an invariant trait: nearly all wild-type individuals in wild-type populations have 4 bristles. Indeed, this trait is diagnostic for the genus *Drosophila*. However, a mutation in the sex-linked gene *scute* reduces the number of bristles to an average of 2 in females and 1 in males. In addition, the number of scutellar bristles is highly variable in *scute* mutants, ranging between 0 and 4 in females, and between 0 and 3 in males. These results suggest that: **[3 points each]**

(a) Wild-type flies show strong phenotypic plasticity in scutellar bristle number. True [ ] False [ ]

(b) Scutellar bristle number has a high environmental variance in wild-type flies. True [ ] False [ ]

(c) *Scute* acts pleiotropically on scutellar bristle number. True [ ] False [ ]

(d) The *scute* mutation causes an increase in either the genetic variance or the environmental variance in scutellar bristle number. True [ ] False [ ]

(e) *Scute* mutants are more canalized than wild-type flies. True [ ] False [ ]

4. After 22 generations of artificial selection for high scutellar bristle number in *scute* mutants, it was observed that mean bristle number increased from 1 to 2.8 in males and from 2 to 3.3 in females. These results suggest that: **[3 points each]**

(a) The low degree of canalization of *scute* mutants had a genetic basis. True [ ] False [ ]

(b) Directional selection for high scutellar bristle number was ineffective due to the high degree of canalization of the base population. True [ ] False [ ]

(c) The response to selection for scutellar bristle number did not have a genetic basis. True [ ] False [ ]

(d) There was cryptic genetic variation for scutellar bristle number in the wild-type population that was released in *scute* mutants. True [ ] False [ ]

(e) The wild-type scutellar bristle phenotype was genetically assimilated into *scute* mutants. True [ ] False [ ]

5. Imagine that when wild-type flies are exposed to geldanamycin (the specific inhibitor of the Hsp90 chaperone) they do not show a significantly different range of scutellar bristle number, when compared to untreated controls. This observation would suggest that: **[3 points each]**

(a) The degree of canalization in scutellar bristle number does not have a genetic basis. True [ ] False [ ]

(b) Hsp90 does not affect the canalization of scutellar bristle number. True [ ] False [ ]

(c) Hsp90 and *scute* act epistatically on scutellar bristle number. True [ ] False [ ]

6. In some butterflies, temperature shock during development causes the generation of color patterns that resemble the normal patterns of populations living at different temperatures. For example, heat-shocking the central European form of *Papilio machon* can produce some individuals with a color pattern resembling that of the Syrian population. Give brief answers to each of the following questions in the space below and/or in the answer sheet at the end.

(a) How would you test whether the differences in the color patterns of the central European and Syrian subspecies of *P. machon* have a genetic basis? **[6 points]**

(b) How would you use a mutation accumulation experiment to compare the degree of genetic canalization of the central European and Syrian populations of *P. machon*? **[8 points]**

(c) How would an increase in the degree of canalization affect the response of the color pattern to heat-shock in the central European subspecies of *P. machon*? Describe how increased canalization can evolve in nature. **[12 points]**

(d) Explain how the Syrian color pattern might be genetically assimilated into the central European population? Would such an outcome imply the inheritance of an acquired characteristic by a Lamarckian process? Discuss. **[10 points]**

(e) Are all changes in genetic canalization necessarily adaptive? Discuss using the case of Hsp90 as an example. **[10 points]**

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