Reading Guide for Charles Darwin, *On the Origin of Species*, 1st Edition.

Read: Chapter 4 (Natural Selection), Paragraphs 1-6, 9-18, 39-46, 50-63, 68-71

Core question:
What are the laws of life?

Introduction:

- → About the author and the book
- → Natural selection
- → How natural selection leads to new species
- → Questions to think about

Charles Darwin (1809 – 1882), an English naturalist, is most well-known for his theory of evolution by natural selection as an explanation of how variations from generation to generation will eventually lead to the emergence of new species. At Darwin's time, most Europeans believed that every species was created separately and was preserved to the present without modifications. During his voyage on the Beagle, however, Darwin observed the distribution of organisms in South America and their geological relations with past inhabitants there, from which he wondered that species were not created independently. After returning to England, he began to collect more facts which he thought could shed light on the mystery of the origin of species, and finally came to the conclusion that new species emerge from earlier ones by the principle of natural selection.

The selected text is Chapter IV of Darwin's *On the Origin of Species*. This chapter focused on the proposed natural selection mechanism, and how it acts to form new species. In brief, natural selection is the process in which favourable traits of individuals within a population are preserved while injurious traits are destroyed. Darwin reasoned that as organisms living in a local environment were in competition with each other, profitable variations of an organism would give it advantage over the others, so it had a higher chance to survive and reproduce, passing the favourable characteristics on to the next generation. Over many generations, organisms with the advantageous features would become dominant within the population. In this way the structure or habits of a species gradually change and this is how natural selection works to cause evolution.

After explaining the theory of natural selection, Darwin then proceeded to show how this process can lead to emergence of new species from a common ancestor. Under the principle of natural selection, more advantageous variations would be preserved and increase in number, while the more disadvantageous variations would become rare. The more numerous species would have a better chance in producing favourable variations and thus further increase in number. On the contrary, the rarer species would be less quickly modified and would become even rarer until it comes to extinction. Using the analogy of domesticated pigeons, Darwin further explained how continued selection for a specific feature could lead to formation of sub-breeds with exaggeration of the feature which was selected for. As slight variations between each generation accumulate, eventually the difference could become great enough for a distinct breed, or even species, to be formed. On the other hand, other varieties without the profitable modifications would suffer from severe competition with the more advantageous forms and would become extinct. Based on the divergence of character and extinction caused by natural selection, Darwin suggested that species existing at present could be descendents from common ancestors.

Darwin's theory of evolution based on natural selection has revolutionized our understanding of the world of life. Darwin's theory suggested that all species, including humans, are descendents of common ancestors. Not only does this idea conflict with religious doctrines, it also challenges the belief of humans' exalted status in the world of living creatures. If humans share a common ancestor with other creatures, what sets us apart from them? Some people have used natural selection to justify colonialism and eugenics, claiming that it was the law of nature for those more intelligent and civilized to conquer and replace those less civilized, so that humans as a species may become more advanced. Others believed that as social welfare prevented the weak from extinction, it was against the law of nature and should be cancelled. Do you agree with such arguments? Can Darwin's theory be applied in a social or political context? Is Darwin's theory misunderstood?

Suggested outline of the text:

1-3: Natural selection

1: A brief introduction to natural selection.

2: Change in condition (physical changes and intrusion of immigrants) can lead to natural selection and modifications in species.

3: Variations are small but sufficient for natural selection to work.

4-5: Natural selection compared with artificial selection

6: Natural selection acted on characters of very trifling importance.

7-8: Skipped

9: Natural selection cannot modify the structure of one species without giving it any advantage.

10-12: Sexual selection (a struggle between the individuals of one sex for the possession of the other sex): by means of defence and means of charm.

13-17: Examples of the action of natural selection:

13-14: Wolf as an example.

15: Nectar producing plant as an example of promoting intercrossing and hence producing vigorous offsprings.

16: Holly trees as an example of bee-enhanced intercrossing between sexually separated plants (a kind of "physiological division of labour").

17: Clover and hive-bees with longer proboscis than humble-bees as an example.

18: A short summary: Natural selection banishes the belief of continued creation, just like geology has almost banished "such views as the excavation of a great valley by a single diluvial wave."

19-38: Skipped.

39-41: Extinction caused by natural selection

39: A brief introduction to the relationship between number and survival, as hinted by geology.

40: Less numerous, less varieties.

41: Extinction due to competitions between near varieties.

42-46: Divergence of character, related to the diversity of inhabitants of any small area

42: Divergence of character is of high importance. Raise the question: How could lesser differences between varieties accumulate and cause diversity?

43: Explained by domestic productions.

44: The same principle is believed to be applicable in nature.

45-46: Examples to show diversification supports the greatest amount of life.

47-49: Skipped

50-66: Action of natural selection, through divergence of character and extinction, on the descendants from a common parent

50-66: Use a figure (Tree of Life) to summarize how the diversity of species derived from divergence of character, principle of natural selection and principle of extinction work together.

64-67: Skipped

68-71: Summary

68: How natural selection works. Sexual selection.

69: Natural selection leads to extinction and divergence of character.

70: Natural selection can explain the nested grouping in the classification of all organic beings.

71: An analogue as a summary: The Tree of Life.

Study Questions (Answers can be found at the end of this section.)

(Para. 1: Natural Selection)
1. What is "Natural Selection"?
(a) Struggle for existence.
(b) Preservation of favourable variations.
(c) Rejection of injurious variations.
(d) Preservation of favourable variations and rejection of injurious variations.

(Para. 3: Natural Selection)
2. The critical condition for natural selection to take place is the existence of changes in the conditions of life. What are these changes?

I. Changes in the physical environment.
II. Variations in the species.

(a) I only.
(b) II only.
(c) I and II.
(d) None of the above.

(Para. 4: Natural Selection vs. Artificial Selection)
3. In terms of selection, Darwin says man can act only on _____ while nature cares _____.
(a) external and visible characters … everything
(b) external and visible characters … internal organs and hereditary characters
(c) nothing … everything
(d) nothing … internal organs and hereditary characters

(Para. 4: Natural Selection vs. Artificial Selection)
4. In terms of selection, Darwin says man selects only for _____ while nature selects for _____.
(a) his own curiosity … the opposite
(b) his own curiosity … good of the being which she tends
(c) his own good … the opposite
(d) his own good … good of the being which she tends

(Para. 4: Natural Selection vs. Artificial Selection)
5. Darwin says man does not rigidly destroy all inferior animals while nature triggers the competition between lives with the slightest changes. What is the main idea here?
(a) Man has more compassion on animals.
(b) Man does not like competition.
(c) Competitions are good.
(d) Nature exercises all characters of a life.

(Para. 6: Natural selection acted on characters of apparently trifling importance)
6. In the Continent, why are people warned not to keep white pigeons?
(a) White pigeons can spread a certain kind of disease.
(b) White pigeons are easily spotted and caught by hawks.
(c) White pigeons and non-white ones will compete.
(d) White pigeons and non-white ones will breed non-white offspring.

(Para. 9: Natural Selection demonstrated by the structures of the young)
7. Which of the following is NOT an example of a structure used only once in an animal's life but of high importance?
(a) The egg tooth of crocodiles, birds and snakes for breaking their eggs during hatching.
(b) The hard tip to the beak of unhatched birds, used for breaking their eggs.
(c) The milk teeth.
(d) Great jaws of some insects, used exclusively for opening their cocoons.

(Para. 10: Sexual Selection)
8. What does sexual selection usually happen between?
(a) Male and male.
(b) Male and female.
(c) Female and female.
(d) No special pattern.

(Para. 10: Sexual Selection)
9. What is the result of sexual selection?
(a) Extinction of the species.
(b) Death of the unsuccessful male.
(c) The unsuccessful male will have few or no offspring.
(d) The unsuccessful female will have few or no offspring.

(Para. 11: Sexual Selection)
10. At the beginning of this paragraph, what example does the author give to illustrate the contest between male birds?
(a) Singing.
(b) Dancing.
(c) Displaying plumage.
(d) Decorating their nests.

(Para. 18: Summary of Natural Selection)
11. According to Darwin, what has natural selection disproved?
(a) Excavation of gigantic valleys by a single diluvial wave.
(b) Formation of the longest lines of inland cliff.
(c) Existence of infinitesimally small inherited modifications.
(d) The belief of continued creation.

(Para. 40: Extinction)
12. Rarity will lead to extinction–what is the key reason?
(a) Rare species produce few offspring and hence are easily attacked by species of numerous individuals.
(b) Rare species produce few offspring. They cannot spread out much to find a more suitable environment.
(c) Rare species produce few offspring and hence are less quickly modified or improved.
(d) Rare species usually have longer life-spans. This implies a higher probability for an individual to be infected by fatal diseases and die.

(Para. 43: Divergence of Character)
13. What enabled Darwin to shed light on how the divergence of character could be possible in nature?
(a) Horse racing.
(b) Pigeon fight.
(c) Geological observations.
(d) Domestic production.

(Para. 46: Divergence of Character)
14. What method do farmers use to raise more crops?
(a) Growing different types of plants in sequential seasons.
(b) Choosing the most productive plants by man's selection.
(c) Growing plants in different orders in the same field.
(d) Letting the field be open to the immigration of other plants.

(Para. 52: Tree of Life)
15. In the tree diagram, how many varieties did m^7 have? What happened to them?
(a) Only 1 variety. It eventually became m^{10}.
(b) 2 varieties. Both became extinct.
(c) 3 varieties. They became o^{14}, e^{14} and m^{14}.
(d) 3 varieties. 2 of them became extinct while 1 survived and produced offspring.

(Para. 71: Tree of Life)
16. What does a fallen-off limb represent?
(a) Those varieties which evolve extremely slowly.
(b) Those whole orders, families, and genera which no longer evolve.
(c) Those whole orders, families, and genera which have no living representative.
(d) Those whole orders, families, and genera which become degenerate.

Answers:

1.d	6.b	11.d	16.c
2.c	7.c	12.c	
3.a	8.a	13.d	
4.d	9.c	14.a	
5.d	10.a	15.d	

— End —