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EuroSciTizen Building on scientific literacy in Evolution

Didactics of Biology Giessen

JLU NEW PATHS. SINCE 1607.

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Dear students,

this questionnaire has been developed in the context of an European research on evolution. Of course, the survey will be anonymous and we will treat the data with care.

Your cooperation is really important to us! So please, fill out the questionnaire carefully: **Check only one answer per question (if not stated otherwise)!** Answering the questions will take about 30 minutes. Please read all the instructions carefully, before answering the questions.

Thank you for your cooperation in advance!

1. What is your age?

_____

2. What is your sex?

☐ male

☐ female

☐ other (specify): _____

3. When did you finish secondary education (year)?

_____

4. Could you choose a field of study during upper secondary education?

☐ Yes (please specify): _____

☐ No

5. Up to which school year did you attend biology classes?

- ☐ until graduation
- ☐ until 1 – 2 years before graduation
- ☐ until 3 – 4 years before graduation
- ☐ until more than 4 years before graduation
- ☐ I had no biology classes in school.

6. Are you enrolled in the subject "biology"/ life sciences (or education with the subject "biology")?

- ☐ yes (Please answer question 8 next.)
- ☐ no (Please answer question 7 next.)

7. Subject you just enrolled to:

- ☐ science (specify): _____
- ☐ humanities (specify): _____
- ☐ engineering (specify): _____
- ☐ economics (specify): _____
- ☐ law (specify): _____
- ☐ education (specify): _____
- ☐ psychology (specify): _____
- ☐ medicine (specify): _____
- ☐ other (specify): _____

8. How interested are you in biological topics?

very high	high	rather high	medium	rather low	low	very low
☐	☐	☐	☐	☐	☐	☐

9. Do you think you know what "evolution" (in biology) means?

- ☐ yes
- ☐ only in parts
- ☐ thereabout
- ☐ no
- ☐ other (specify): _____

10. Did you learn something about evolution in school?

- ☐ yes
- ☐ no
- ☐ I do not know.

11. Did you spend your whole school career in the country where you live now?

- ☐ yes (Please answer question 13 next.)
- ☐ no (Please answer question 12 next.)

12. In which other country did you go to school and when did you live there?

country: _____

age: from _____ to _____

13. Which denomination do you officially belong to?

- ☐ Protestant
- ☐ Christian free churches
- ☐ Catholic
- ☐ Orthodox
- ☐ Jewish
- ☐ Muslim (Sunni)
- ☐ Muslim (Alevi)
- ☐ Muslim (Shiite)
- ☐ Hindu
- ☐ Buddhist
- ☐ None
- ☐ other (specify): _____

A. **Please carefully read the information texts and the possible answers. After that, check the answers which best suit a scientific point of view (according to your opinion). Important note: only check <u>one</u> answer per question!**

A1.

Venus flytraps are carnivorous plants. They occur on soil with only few nutrients. With the help of specifically adapted trapping leaves, they can also feed on insects by catching them. Therefore, the supply of nutrients is enhanced and the plants can grow.

How did the leaves evolve over time?

Venus flytrap.

Some Venus flytraps recognized the nutrient deficiencies and transformed their leaves in response into trapping leaves. As a result, they could also feed on insects and survived with greater ease. (A101)	☐
Because of the nutrient deficiency, the Venus flytraps automatically received their trapping leaves. Hence, they had a survival advantage. (A102)	☐
Nature has adapted the Venus flytraps to the nutrient deficient soil, so they can grow better. (A103)	☐
Some Venus flytraps randomly had trapping leaves and additionally were able to consume insects on the nutrient deficient soil. Therefore, more Venus flytraps with trapping leaves were able to survive and reproduce. (A104)	☒
In order to grow better, the Venus flytraps adapted to the nutrient deficient soil. (A105)	☐
I do not know. (A106)	☐

A2.

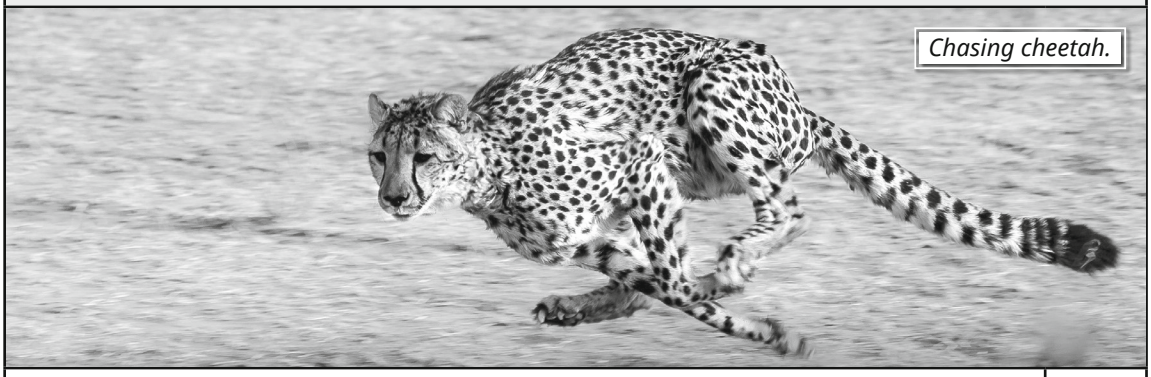
Biologists often use the term „fitness“ when speaking of evolution. Below are descriptions of four male lions.

Which lion would you consider the fittest? Please check in the table below.

Name	**George (A201)**	**Ben (A202)**	**Spot (A203)**	**Sandy (A204)**	I do not know. **(A205)**
Length with tail	3 m	2,55 m	2,7 m	2,7 m	
Weight	173 kg	160 kg	162 kg	160 kg	
Number of cubs fathered	19	25	20	20	
Age of death	13 years	16 years	12 years	9 years	
Number of cubs surviving to adulthood	13	14	14	19	
Comments	George was very large, very healthy. The strongest lion	Ben had the greatest number of females in his harem	When the area that Spot lived in was destroyed by fire, he was able to move his pride to a new area and change his feeding habits	Sandy was killed by an infection resulting from a cut in his foot	
The “fittest“ lion is:	☐	☐	☐	☒	☐

A3.

When chasing their prey, cheetahs are able to run up to 64.6 mph (104 km/h).
In comparison, their ancestors were only able to reach a speed of 19.9 mph (32 km/h).
How did the ability to run fast evolve in cheetahs?



Chasing cheetah.

In order to catch more prey, the cheetahs adapted their speed. (A3O1)	☐
Some cheetahs randomly were faster and were able to catch more prey. Therefore, more of the faster cheetahs were able to survive and reproduce. (A3O2)	☒
Nature has adapted the running speed of cheetahs, so they can catch more prey. (A3O3)	☐
Some ancestors of the cheetahs recognized that they could not catch enough prey. Hence, they increased their running speed. As a result, they were able to catch more prey and survive with greater ease. (A3O4)	☐
Because they were able to catch more prey this way, the running speed increased automatically. Hence, they had a survival advantage. (A3O5)	☐
Some ancestors of the cheetahs recognized that they could not catch enough prey. Hence, they trained in order to run faster. (A3O6)	☐
I do not know. (A3O7)	☐

A4.

A group of lizards lives in a valley. Due to an earthquake, a deep and broad canyon is created. From then on, this canyon separates the habitat (living space) of the lizards. Consequently, the group of lizards is split into two smaller groups. After several thousand years, the canyon closes at one point and lizards from both of the separated groups share a habitat (living space) together once again. **How would the groups have evolved?**

One of the lizards in the valley.

Both groups would have evolved into the same direction - one could not distinguish them from each other. (A4O1)	☐
A different evolution of both groups would only be possible if both of the separated habitats (living spaces) were very different. (A4O2)	☐
It cannot be predicted in which way the groups have evolved. (A4O3)	☒
Both groups would have evolved in no way, everything would be just as before. (A4O4)	☐
Both groups would have evolved in different directions - one could easily distinguish them (from each other). (A4O5)	☐
I do not know. (A4O6)	☐

A5.

The shells of banded snails can have different colours. In the forest, where the ground tends to be browner, snails with dark shells more frequently live. Snails with lighter colour more frequently live on meadows, where this colour is a better camouflage. Therefore, they can hide better from their enemies, the song thrushes. **How did this happen?**

Different banded snails.

Since this was a better way to hide from the song thrushes, the light coloured snails changed their former colour automatically. Hence, they had a survival advantage. (A5O1)	☐
Nature has adapted the light coloured snails to the habitat (meadows), so they have a better camouflage. (A5O2)	☐
Some dark coloured snails recognized that they had to change their colour in order to have a better camouflage. Therefore, they ate more light coloured food in order to change their shells into a lighter colour. (A5O3)	☐
In order to have a better camouflage, the dark coloured snails adapted to the habitat (meadow). (A5O4)	☐
Some dark coloured snails recognized that they had to change their colour in order to have a better camouflage. Therefore, they changed their colour. As a result, they were eaten less frequently and were able to survive more easily. (A5O5)	☐
Some snails randomly had a lighter colour and were not spotted so easily (on the meadow) by the song thrushes. Therefore, more light coloured snails were able to survive and reproduce. (A5O6)	☒
I do not know. (A5O7)	☐

A6.

There is little water in deserts. Throughout the day, it is hot and the sun shines with great intensity. For many plants this is bad, because they lose a lot of water due to the heat and the dry air. From cacti with leaves, first cacti with smaller leaves and then leafless cacti with thorns evolved.
How did this happen?

Leafless cactus with thorns.

In order to lose less water, the cacti adapted to the desert habitat. (A6O1)	☐
Some cacti with leaves recognized that they lost too much water. Hence, they shrunk their leaves. As a result, they lost less water and were able to survive more easily. (A6O2)	☐
Some cacti randomly had smaller leaves and lost less water in the desert. Consequently, more cacti with smaller leaves were able to survive and reproduce. (A6O3)	☒
The cacti had smaller leaves automatically, because they lost less water in the desert this way. Hence, they had a survival advantage. (A6O4)	☐
Nature has adapted the cacti to their desert habitat, so they lose less water. (A6O5)	☐
I do not know. (A6O6)	☐

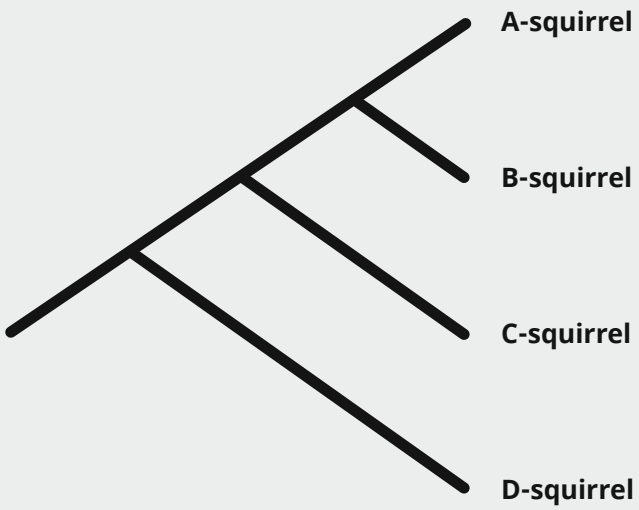
A7.

At the end of the 19th century, the zoologist August Weismann conducted the following experiment: He completely cut off the tail of mice in order to determine which consequences this might have on the mice's direct offspring. **How would the mice's offspring look like?**	
On average, their tails would be a little shorter than the tails of the parents. (A7O1)	☐
They would still have a tail which would not be used anymore. (A7O2)	☐
They would have no tail. (A7O3)	☐
Cutting off the tails would not have an effect on the offspring's tail length. (A7O4)	☒
I do not know. (A7O5)	☐

A8.

Assuming that Mr. Weismann also would have cut off the offspring's tails and their descendants etc., for a total of 20 generations. **How would the mice of the 21st generation look like?**	
On average, their tails would be significantly shorter as the tails of the parents from the first generation. (A8O1)	☐
They would still have a tail which would not be used anymore. (A8O2)	☐
They would have no tail. (A8O3)	☐
Cutting off the tails would not have an effect on the offspring's tail length. (A8O4)	☒
I do not know. (A8O5)	☐

A9.1



The figure shows the evolution of fictional squirrel species.
Tick the time arrow which represents the real timeline.

 (A9.101)	 (A9.102)	(A9.103)	(A9.104)	 (A9.105)	 (A9.106)	 (A9.107)	 (A9.108)	I do not know. (A9.109)
☐	☐	☒	☐	☐	☐	☐	☐	☐

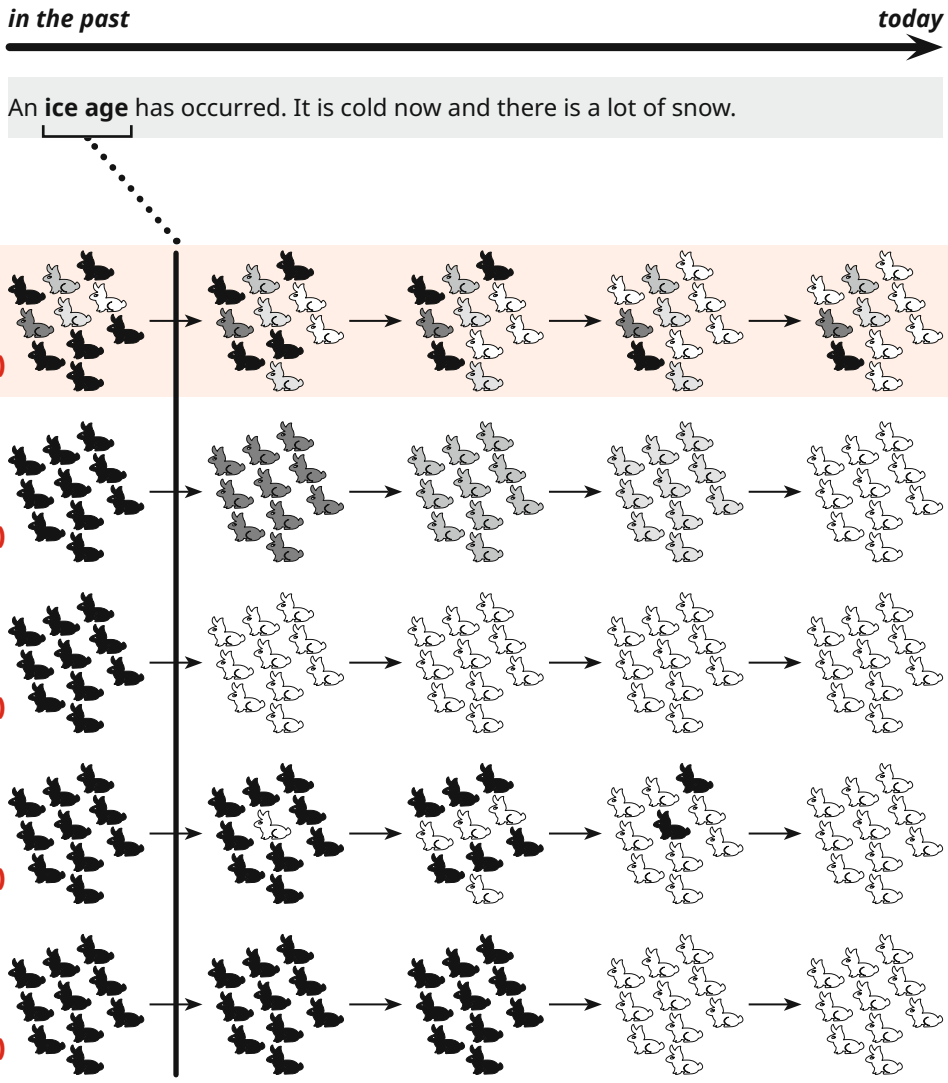
A9.2

The figure shows a family tree of the relationship between four different squirrel species.
Which of the following statements corresponds to the family tree?

C-squirrels are ...

... most closely related to A-squirrels. (A9.201)	☐
... most closely related to B-squirrels. (A9.202)	☐
... most closely related to D-squirrels. (A9.203)	☐
... as closely related to A as to B-squirrels. (A9.204)	☒
... as closely related to B as to D-squirrels. (A9.205)	☐
... as closely related to A as to B and D-squirrels. (A9.206)	☐
I do not know. (A9.207)	☐

A10. Which of the illustrated long-term developments after the ice age is the most likely?



F.
(A10O6) It is different, namely: _____

_____

_____

_____

_____

A11. Which of these is the closest relative to the chimpanzee?

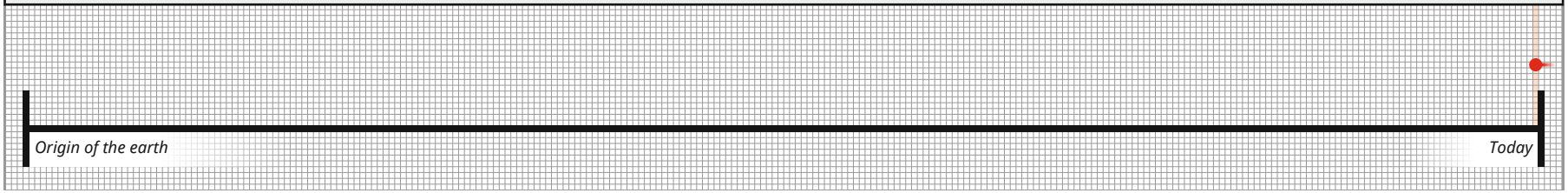
gorilla	human	orang-utan	baboon	I do not know.
☐ (A1101)	☒ (A1102)	☐ (A1103)	☐ (A1104)	☐ (A1105)

B.	The following statements are either true or false. Please decide on only one answer per statement.	true	false	I do not know.
B1.	A new species forms when a single animal or plant adapts to new living conditions.	☐	☒	☐
B2.	Evolution always leads to improvement.	☐	☒	☐
B3.	Humans and chimpanzees evolved from a common ancestor, which was an ape, independently.	☒	☐	☐
B4.	The better a living organism is adapted to the environmental conditions the higher is the probability that it will have more offspring.	☒	☐	☐
B5.	Without differences between individuals, there can be no speciation.	☒	☐	☐
B6.	The biological evolution of Mankind is completed.	☐	☒	☐

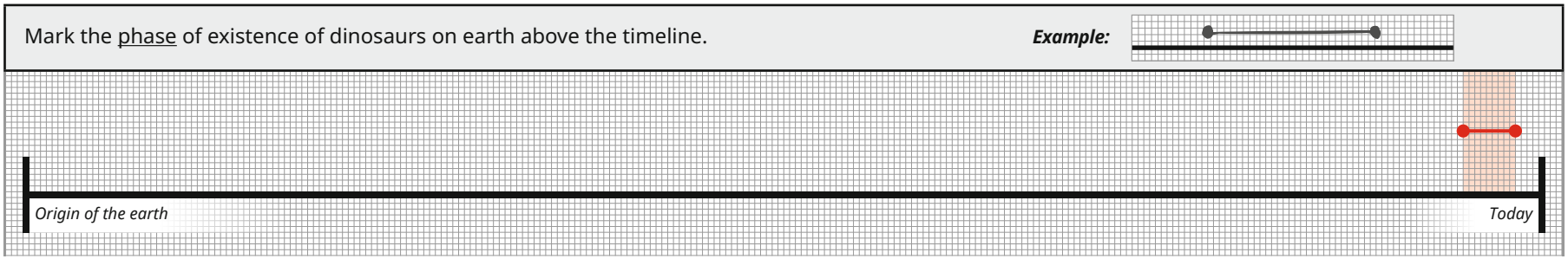
B7.	The following statements are either true or false. Please decide on only one answer per statement:	true	false	I do not know.
B7.1	Mutations happen randomly.	☒	☐	☐
B7.2	Mutations are usually controlled by the plants and animals themselves.	☐	☒	☐
B7.3	Mutations are always negative.	☐	☒	☐
B7.4	Mutations can be neutral in their effects.	☒	☐	☐
B7.5	Under normal conditions, mutations do not occur in living beings.	☐	☒	☐
B7.6	Mutations can take place independently of environmental changes.	☒	☐	☐

C. In the following, mark time points or time periods on timelines. To do this, mark the time point or time period above the timeline.
Advice: All timelines show the same time period (from the origin of the earth to today).
Please keep this in mind while marking the phases and points of time.

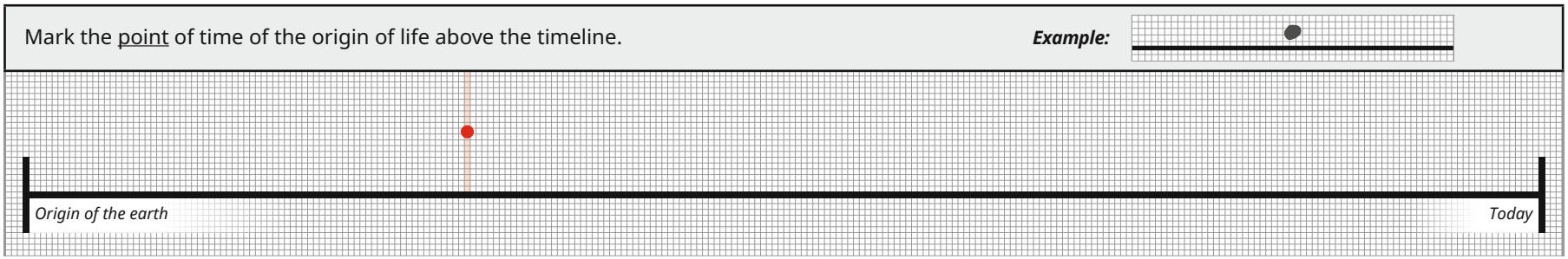
C1. Mark the phase of existence of humans on earth above the timeline. ***Example:***



C2. Mark the phase of existence of dinosaurs on earth above the timeline. ***Example:***



C3. Mark the point of time of the origin of life above the timeline. ***Example:***



D. Please indicate to what extent you agree with the following statements about the mind and the brain.

The word "mind" – in the statements below – represents what defines you as a person and is often translated as "soul", "personality", or "self".

		Agree	Somewhat agree	Undecided	Somewhat disagree	Disagree
D1.	**The mind is in principle independent of the body; it is only temporarily attached to the body.**	☐	☐	☐	☐	☐
D2.	**In principle, the mind can solely be ascribed to natural processes in the brain.**	☐	☐	☐	☐	☐
D3.	**My mind will survive the death of my body.**	☐	☐	☐	☐	☐
D4.	**Mental processes are NOTHING more than the result of brain activity.**	☐	☐	☐	☐	☐
D5.	**Whenever I use the word "mind", I only use it as a simplification of the complicated things my brain does.**	☐	☐	☐	☐	☐

E. Please indicate to what extent you agree with the following statements about evolution.

In my personal opinion, ...

		Agree	Somewhat agree	Undecided	Somewhat disagree	Disagree
E1.	**...the entire world of living organisms has developed over billions of years.**	☐	☐	☐	☐	☐
E2.	**...our consciousness is a product of natural evolutionary processes.**	☐	☐	☐	☐	☐
E3.	**...the adaptations of living organisms to their environments can be explained by the theory of evolution.**	☐	☐	☐	☐	☐
E4.	**...our intellectual capacity has NOT developed via natural evolutionary processes.**	☐	☐	☐	☐	☐
E5.	**...the animals and plants we know today have developed from earlier species.**	☐	☐	☐	☐	☐
E6.	**...our sense of morality is partly the result of natural evolution.**	☐	☐	☐	☐	☐
E7.	**...the modern living organisms are the result of evolutionary processes which occurred over billions of years.**	☐	☐	☐	☐	☐
E8.	**...something as complex as our consciousness CANNOT result from evolution.**	☐	☐	☐	☐	☐

F. Please indicate to what extent you agree with the following statements about faith/religion.

		Agree	Somewhat agree	Undecided	Somewhat disagree	Disagree
F1.	**I believe in God.**	☐	☐	☐	☐	☐
F2.	**I feel that God exists.**	☐	☐	☐	☐	☐
F3.	**I think there are good arguments for the existence of God.**	☐	☐	☐	☐	☐
F4.	**I would describe myself as a faithful person.**	☐	☐	☐	☐	☐
F5.	**Without faith, my life is/would be pointless.**	☐	☐	☐	☐	☐
F6.	**I believe there is a heaven.**	☐	☐	☐	☐	☐
F7.	**I pray and believe that my prayers can change what happens (in the future).**	☐	☐	☐	☐	☐
F8.	**I feel most fulfilled when I am in a close connection with God.**	☐	☐	☐	☐	☐
F9.	**Because of my faith, I have hope for a life after death.**	☐	☐	☐	☐	☐
F10.	**My life is meaningful, because I am wanted by God.**	☐	☐	☐	☐	☐

Image sources:
Cheetah: DrZoltan/pixabay – Venus Flytrap: naokivin/pixabay – Lizards in the valley: Alexas_Fotos/pixabay – Banded Snails: zimt2003/pixabay – Leafless Cactus: Pexels/pixabay