

School of Bioscience

WRITTEN EXAMINATION

Course Evolution G1F

Sub-course

Course code BV314G

Credits for written examination 4,5

Date 2022-05-31

Examination time 14:15 - 19:30

Examination responsible Tomas Jonsson

Teachers concerned Tomas Jonsson

Aid at the exam/appendices No aids (Inga hjälpmedel)

Other Take a new sheet of paper when starting every new part of the exam (4 parts)!
(Börja varje del av tentan (4 delar) på nytt blad!)

Instructions

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Take a new sheet of paper for each teacher.

Take a new sheet of paper when starting a new question.

Write only on one side of the paper.

Write your name and personal ID No. on all pages you hand in.

Use page numbering.

Don't use a red pen.

Mark answered questions with a cross on the cover sheet.

Grade points If every course objective has been passed ($\geq 50\%$ score on every objective) the final grade is set by the total score according to the following (preliminary) scale:
A $\geq 90\%$, B $\geq 80\%$, C $\geq 70\%$, D $\geq 60\%$, E $\geq 50\%$

Examination results should be made public within 18 working days

Good luck!

Written exam Evolution BV314G Vt24

Dear student! Welcome to the final exam on the course Evolution (BV314G).

I suggest that you:

- Read through all the questions before you start writing. Note questions if you need to ask me something. I will be visiting you at least once during the exam.
- Take a new sheet of paper when starting every new part of the exam (4 parts)!
- Read every question carefully. If needed, read it more than once.
- Start with the questions you think are easy. This builds confidence and is smart time management.
- Write clear and precise answers that answers the actual question.
- If you draw figures or images to help with your explanation, make sure to explain the drawing with words. **Also, make sure that you include specifications of axes in every diagrams!** Figures or images without explanations will not be rewarded any points.

Grade points: The exam consists of four parts corresponding to learning objectives. Each objective is tested by 3-4 questions. The maximum score for each knowledge objective is 10 points. To pass the exam the student must score 50% or more of the total points on each of the four objectives. The final grade on the exam, provided that a pass has been reached, is determined by total score according to the following scale: A ≥ 90 %, B ≥ 80 %, C ≥ 70 % and D ≥ 60 %

I wish you good luck!

Sincerely Tomas Jonsson (Responsible teacher)

1. **Part 1. Learning objective: the student should be able to explain and analyse evolutionary mechanisms (such as adaptation, fitness, mutations, genetic drift, migration) as well as different types of selection, and discuss their relevance for the process of evolution.**

Questions (10p, E $\geq$ 5p):

- 1.1. **In English:** The theory of evolution is considered to be one of the big science 'discoveries' and is the theory that unifies all aspects of biology. Describe how evolution by means of natural selection works and what it leads to: what are the parts (i.e. observations and conclusions or postulates) of the theory that needs to apply and that together are considered to lead to evolution by natural selection? Your presentation must include and define the terms *fitness* and *adaptation*. (4p)

In Swedish: Evolutionsteorin anses vara en av naturvetenskapens stora "upptäckter" och är den teori som förenar alla delar av biologin. Beskriv hur evolution genom naturlig selektion (*evolution by means of natural selection*) fungerar och vad det leder till: vilka är delarna (dvs observationer och slutsatser eller förutsägelser) i teorin som ska gälla och som tillsammans anses leda till evolution genom naturlig selektion? Din redogörelse ska innehålla och definiera termerna *fitness* och *adaptation*. (4p)

- 1.2. **In English:** There are different types of selection. Explain the meaning of (i) *directional* selection, (ii) *disruptive* selection and (iii) *stabilizing* selection, and describe how they work. Illustrate this using graphs that show (a) what the selective pressure looks like (i.e. how does fitness vary among different 'types of individuals' and which type of individuals are selected for and against, respectively?) and (b) how the phenotypic distribution changes as a result of directional, disruptive and stabilizing selection (i.e. compare the phenotypic distribution 'before' and 'after' selection under the three scenarios). (6p)

In Swedish: Det finns olika typer av selektion. Förklara innebörden av (i) *riktad* selektion, (ii) *splittrande* selektion, samt (iii) *stabiliserande* selektion och redogör för hur de fungerar. Illustrera med hjälp av figurer hur (a) selektionstrycket ser ut (dvs vilken fitness har olika typer av individer och vilka gynnas/missgynnas?) och (b) hur den fenotypiska fördelningen förändras under riktad, splittrande samt stabiliserande selektion (dvs jämför den fenotypiska fördelningen "före" och "efter" selektionen under de tre scenarierna). (6p)

2. **Part 2. Learning objective:** the student should be able to describe how the view of species and their (in)variance over time has changed historically, describe main features in the evolutionary history of organisms (including the evolution of humans) and theories about the origin of life and evolution of the cell.

Questions (10p, E $\geq$ 5p):

- 2.1. **In English:** 'Abiogenesis' is the idea that living cells can arise from chemical compounds under the environmental conditions that supposedly prevailed at the time when life emerged on earth.

2.1.a. Describe how life on earth is hypothesized to have begun (more specifically, the steps leading up to a living cell), according to the scientific hypothesis of abiogenesis. (2p)

2.1.b. Give one example of evidence/fact that supports the claim that all life on earth has a single common origin AND explain why/how it supports this claim. (2p)

In Swedish: "Abiogenes" är idén att levande celler kan uppstå från kemiska föreningar under de miljöförhållanden som förmodas rådde vid den tidpunkt då liv uppstod på jorden

(a) Beskriv hur livet på jorden antas ha börjat (mer specifikt stegen som leder fram till en levande cell), enligt den vetenskapliga hypotesen för abiogenes. (2p)

(b) Ge ett exempel på bevis/fakta som stödjer påståendet att allt liv på jorden har ett gemensamt ursprung OCH förklara varför/hur det stödjer detta påstående. (2p)

- 2.2. **In English:** Summarize the evolutionary history of humans by drawing a simple phylogenetic tree of the following species: *Homo sapiens*, *Homo erectus*, *Homo habilis*, *Homo ergaster*, *Homo neanderthalensis*, *Homo antecessor/heidelbergensis*. Include the assumed distribution of the different species (i.e. on what continents did they live?). (3p)

In Swedish: Sammanfatta översiktligt människans evolutionära historia genom att placera in följande arter i ett enkelt släktträd; *Homo sapiens*, *Homo erectus*, *Homo habilis*, *Homo ergaster*, *Homo neanderthalensis*, *Homo antecessor/heidelbergensis*. Ange även de olika arternas sannolika utbredning (dvs på vilka kontinenter fanns de?). (3p)

- 2.3. **In English:** Arrange the great apes (gibbon, chimpanzee, orangutan and gorilla) in order of relatedness to humans. (1p)

In Swedish: Rangordna människoaporna (gibbon, schimpans, orangutang samt gorilla) efter hur nära släkt de är med människan. (1p)

- 2.4. **In English:** Briefly describe two problems/weaknesses in the theory of evolution (= 'Darwin's dilemmas') when it finally was presented in 1859 and how they eventually were 'solved'. (2p)

In Swedish: Redogör kortfattat för två problem/svagheter med evolutionsteorin (= "Darwins dilemman") då den slutligen presenterades 1859 och hur de till slut fick sin lösning. (2p)

3. Part 3. Learning objective: the student should be able to explain principles of speciation as well as the cladistic method of creating evolutionary (phylogenetic) trees.

Questions (10p E ≥ 5p):

3.1. In English: Briefly define/explain the meaning of the following terms/concepts (6p in total):

- a) *homologous* character (1p)
- b) *analogous* character (1p)
- c) *outgroup* in cladistics (1p)
- d) *maximum parsimony* (=Occam's razor) and the 'most likely tree' in cladistics (1p)
- e) *Sympatric* speciation (1p)
- f) *Allopatric* speciation (1p)

In Swedish: Definiera/förklara kortfattat innebörden av följande termer/begrepp (6p totalt):

- a) *homolog* egenskap (1p)
- b) *analog* egenskap (1p)
- c) *outgroup* inom kladistik (1p)
- d) *Ockhams rakkniv* (=maximum parsimony) och det "mest sannolika trädet" i kladistik (1p)
- e) *Sympatrisk* artbildning (1p)
- f) *Allopatrisk* artbildning (1p)

3.2. In English: Explain why, from a cladistics point of view, it can be correct to say that we are 'fishes' (4 p). More specifically, your answer should in your own words (i) describe the meaning of the cladistics terms *monophyly*, *paraphyly* and *polyphyly*, and based on this explain why, from a cladistics point of view, it can be correct to say that we (and all other mammals as well) are 'fishes' (and that birds are dinosaurs).

In Swedish: Förklara varför det ur ett kladistiskt perspektiv kan vara korrekt att säga att vi är "fiskar" (4 p). Mer specifikt, ditt svar ska med egna ord (i) beskriva innebörden av de kladistiska termerna *monofyli*, *parafyli* och *polyfyli*, samt baserat på detta förklara varför det ur ett kladistiskt perspektiv kan vara korrekt att säga att vi (och alla andra däggdjur) är "fiskar" (och att fåglar är dinosaurier).

4. Part 4. Learning objective: the student should be able to give an evolutionary perspective on basic morphology, physiology and life history characteristics of organisms.

Questions (10p, E ≥ 5p):

4.1. In English: Briefly define/explain the meaning of the following terms/concepts within life-history theory (6p in total):

- a) Life-history characteristics (1p)
- b) Trade-offs (1p)
- c) Constraints (1p)
- d) The principle of energy allocation (1p)
- e) 'Darwinian demon' (1p)
- f) Iteroparous organism (1p)

In Swedish: Definiera/förklara kortfattat innebörden av följande termer/begrepp inom livshistorieteori (6p totalt):

- a) Livshistorieegenskap (1p)
- b) Trade-offs (1p)
- c) Begränsningar (1p)
- d) Principen om energiallokering (1p)
- e) "Darwiniansk demon" (1p)
- f) Iteropar organism (1p)

4.2. In English: *Optimal clutch size* is an important concept in life-history theory. Explain (i) what optimal clutch size means, (ii) what factors affect it, and (iii) why the optimal clutch size of organisms rarely is to produce as many offspring as physiologically possible at a reproductive event. (4p)

In Swedish: *Optimal kullstorlek* är ett viktigt begrepp inom livshistorieteorin. Förklara (i) vad optimal kullstorlek innebär, (ii) vilka faktorer som påverkar den och (iii) varför den optimala kullstorleken hos organismer sällan är att producera så många avkommor som är fysiologiskt möjligt vid ett reproduktionstillfälle. (4p)