ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ
ΤΜΗΜΑ ΒΙΟΛΟΓΙΑΣ

ΕΡΓΑΣΤΗΡΙΟ ΖΩΟΛΟΓΙΑΣ
ΥΠΕΥΘΥΝΟΙ ΚΑΘΗΓΗΤΕΣ: ΝΙΚΟΛΑΟΣ ΠΟΥΛΑΚΑΚΗΣ, ΜΙΧΑΛΗΣ ΠΑΥΛΙΔΗΣ

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ΕΙΣΑΓΩΓΗ ΣΤΗ ΖΩΟΛΟΓΙΑ

Π Ρ Ω Τ Ο Ζ Ω Α

Eukaryogenesis
Classification

Επιμέλεια
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EUKARYOGENESIS

Eukaryogenesis – the emergence of eukaryotic cells.

Age: Microfossils indicate that ~1.7 Ga is a robust earliest date for the appearance of eukaryotes.
The oldest member of an identifiable extant group is the fossil Bangiomorpha, a rhodophyte alga from the ~1.2-Ga, Hunting Formation of Canada.

Two main theories: Intracellular coevolutionary theory, Endosymbiosis theory

Prokaryotic parasitism theory for eukaryogenesis (bacteria genes + archaea genes + eukarya genes)

Eukaryogenesis. A multi-step process. 60 major innovations

1. Ενδοκυττάρια συνεξέλιξη οργανιδίων

A. Flexible outer boundary
   - Εκταση. Αύξηση μεγέθους του κυττάρου. Αύξηση εξωτερικής μεμβράνης
   - Αναδίπλωση. Ευκαρυωτικό Ενδομεμβρανικό σύστημα. Αύξηση εσωτερικής μεμβράνης
   - Εσωπτύχωση. Εδρα ενζυμικών αντιδράσεων, όπως φωτοσύνθεση, αναπνοή. Αύξηση εσωτερικής μεμβράνης
   - Lipid biosynthesis. One cellular feature that has puzzled evolutionary biologists aiming to resolve eukaryogenesis is lipid biosynthesis.

   - DNA Internalization

     Πυρήνας
     κυκλικό DNA > γραμμικό DNA
     n > 2n >
     Μίτωση, Μείωση
     Ελεγχος γονιδιακής έκφρασης

B. Eukaryotic cytoskeleton
   - Cell form/shape
   - Καθορισμένη θέση οργανιδίων του κυττάρου. Κυτταρική διαμερισματοποίηση. Φαινόμενα Κλίμακας (SA/V)
   - Cytoplasmic streaming
   - Flagella, cilia
   - Mitotic spindle

Γ. Phagocytosis. [Εγκόλπωση. Κυστίδια.] Ενδοκύτωση (φαγο-, πινο-). Εξωκύτωση

2. Ενδοσυμβίωση

Mitochondrion, Plastids
HGT/EGT
Kleptoplastidy

Ποιά είναι τα κύρια χαρακτηριστικά γνωρίσματα των πρωτίστων:

1. **Ως προς το επίπεδο οργάνωσης;**
   Protists are unicellular, colonial or they are **multicellular without specialized tissues and embryo development**, and this **simple cellular organization** distinguishes the protists from other eukaryotes, such as fungi, animals and plants.

2. **Ως προς το περιβάλλον τους;**
   Protists live in almost any **environment** that contains **liquid water**.
   Many protists, such as the algae, are photosynthetic and are vital primary producers in ecosystems, particularly in the ocean as part of the **plankton**. Other protists include pathogenic species such as the kinetoplastid *Trypanosoma brucei*, which causes sleeping sickness and species of the apicomplexan *Plasmodium* which cause malaria.

Ποιά είναι τα κύρια χαρακτηριστικά γνωρίσματα των Πρωτοζώων;

In general, **protozoa** are referred to as **animal-like protists because of heterotrophy and movement.**
Το κοινό χαρακτηριστικό όλων των φύλων των πρωτοζώων είναι ότι πρόκειται για μονοκύτταρους ή αποικιακούς ευκαρυωτικούς οργανισμούς που ζούν σε υγρό περιβάλλον.

Οι σημαντικότερες ομάδες πρωτοζώων/πρωτίστων που θα μας απασχολήσουν είναι:

1. Τα ΒλεφαριδοφόραCiliates
2. Τα ΑκροσυμπλεγματικάApicomplexans
3. Τα ΣαρκώδηSarcodina και
4. Τα ΜαστιγοφόραFlagellates

Τα σημαντικότερα χαρακτηριστικά γνωρίσματα και συνήθη γένη των παραπάνω ομάδων περιγράφονται στο «Φύλλο Εργασίας» της εργαστηριακής άσκησης «ΠΡΩΤΟΖΩΑ».

Στην παρακάτω προτεινόμενη κατάταξη κατά Ruggiero et al. στο Βασίλειο των Πρωτοζώων περιλαμβάνονται τα Φύλα: Euglenozoa, Loukozoa, Metamonada, Percolozoa, Amoebozoa, Choanozoa, Microsporidia και Sulkozoa.

A Higher Level Classification of All Living Organisms, 2015

Michael A. Ruggiero , Published: April 29, 2015, https://doi.org/10.1371/journal.pone.0119248
Ruggiero, M.A., Gordon, D.P., Orrell, T.M., Bailly, N., Bourgoin, T., Brusca, R.C., Cavalier-Smith, T., Guiry, M. D. & Kirk, P. M. (2015).

ΠΡΩΤΟΖΩΑ

A Higher Level Classification of All Living Organisms, 2015

Michael A. Ruggiero , Published: April 29, 2015, https://doi.org/10.1371/journal.pone.0119248

Superkingdom Eukaryota **A**.SUBKINGDOM **EOZOA** 1/2

Kingdom Protozoa

A.Subkingdom **Eozoa** 1/2 **B**.Subkingdom **Sarcomastigota** 2/2

Infrakingdom **Euglenozoa** 1/2

1.Phylum Euglenozoa

Subphylum n.n.

Class diplonemea	Order diplonemida
Class kinetoplastea	Order bodonida, Order prokinetoplastida, Order trypanosomatida (Trypanosoma brucei, Trypanosoma cruzi Leishmania sp) *T. b. brucei*, *T. b. gambiense* and *T. b. rhodesiense*.

Subphylum Euglenoida

Class N.N.	Order Petalomonadida, Order Ploeotiida
Class **Euglenophyceae**	Order Eutreptiida, Order Euglenida (Phacus, Euglena)
Class Peranemea	Order Heteronemida, Order Peranemida, Order Rhabdomonadida

Subphylum Symbiontida

Class Postgaardea	Order Postgaardida

Infrakingdom **Excavata** 2/2

2.Phylum Loukozoa

Subphylum Eolouka

Class Jakobea	Order Jakobida
Class Tsukubea	Order Tsukubamonadida

Subphylum Neolouka

Class Malawimonadea	Order Malawimonadida

3.Phylum Metamonada [Amitochondriate]

Class Anaeromonadea	Order Oxymonadida, Order Trimastigida
Class Carpomonadea	Order Carpediemonadida, Order Chilomastigida, Order Dysnectida
Class Eopharyngea	Order Diplomonadida (Giardia lamblia), Order Retortamonadida
Class Trichomonadea	Order Cristamonadida, Spirotrichonymphida, Order Tritrichomonadida Trichomonadida (Trichomonas vaginalis)
Class Trichonymphea	Order Lophomonadida, Order Trichonymphida (Trichonympha) (Spirotrichonympha)

4.Phylum Percolozoa

Subphylum Pharyngomonada

Class Pharyngomonadea	Order Pharyngomonadida

Subphylum Tetramitia

Class Heterolobosea	Order Acrasida, (Acrasis) Order Schizopyrenida (Naegleria fowleri/μηνιγγίτιδαmeningitis)
Class Lyromonadea	Order Lyromonadida
Class Percolatea	Order Percolomonadida, Order Pseudociliatida

B.Subkingdom **Sarcomastigota** 1/2

1.Phylum Amoebozoa

2.Phylum Choanozoa [with Microsporidia, Animalia, and Fungi constitutes "Supergroup Opisthokonta"]

3.Phylum Microsporidia [with Choanozoa, Animalia, and Fungi constitutes "Supergroup Opisthokonta"]

4.Phylum Sulcozoa

Superkingdom Eukaryota

Kingdom Protozoa

A.Subkingdom **Eozoa** 1/2

B.SUBKINGDOM **SARCOMASTIGOTA** 2/2

B.Subkingdom **Sarcomastigota** 2/2

1.Phylum Amoebozoa

Subphylum Conosa 1/2

Class Archamoebea 1/5 — Order Mastigamoebida, Order Pelobiontida, (Pelomyxa palustris)
(Entamoeba histolytica) — Order Rhizomastigida

Class Dictyostelea 2/5 — Order Dictyostelida (cellular slime molds- Dictyostelium discoideum)

Class Myxogastrea 3/5 [= **Myxomycetes.** plasmodial or acellular slime moulds]
Subclass Exosporeae — Order Ceratiomyxida

Subclass Myxogastria (Fuligo septica, Physarum polycephalum>Physarales)
Superorder Columelida
Order Echinosteliida, Order Fuscisporida

Superorder Lucisporida
Order Liceida, Order Trichiida

Class Protostelea 4/5 — Order Protostelida
Class Variosea 5/5 — Order Artodiscida, Order Holomastigida, Order Phalansteriida
Order Varipodida

Subphylum Lobosa 2/2

Class Discosea 1/2
Subclass Flabellinia — Order Dactylopodida, Order Himatismenida, Order Pellitida
Order Stygamoebida, Order Trichosida, Order Vanellida

Subclass Longamoebia
Order Dermamoebida, Order Thecamoebida (Thecamoeba)
Order Centramoebida (Acanthamoeba keratitis)

Class Tubulinea 2/2 [= **Lobosea**] (Tubulunida: Chaos carolinense, Amoeba proteus)
Order Arcellinida (Arcella, Difflugia), Order Echinamoebida
Order Euamoebida, Order Leptomyxida, Order Nolandida

2.Phylum Choanozoa [with Microsporidia, Animalia, and Fungi constitutes "Supergroup Opisthokonta"]

Subphylum Choanofila 1/2

Class Choanoflagellatea — Order Acanthoecida, Order Craspedida (Codosida/Codonosida)

Class Corallochytrea — Order Corallochytrida
Class Filasterea — Order Ministeriida
Class Ichthyosporea — Order Dermocystida

Subphylum Paramycia 2/2

Class Aphelidea — Order Aphelidida
Class Cristidiscoidea — Order Fonticulida (cellular slime molds), Order Nucleariida
Class Rozellidea — Order Rozellida

3.Phylum Microsporidia [with Choanozoa, Animalia, and Fungi constitutes "Supergroup Opisthokonta"]

Class Disporea — Order N.N. (e.g., Nosema)
Class Metchnikovellea — Order Metchnikovellida

Class Minisporea [= Microsporea]
Order Minisporida [= Minisporea]

Class Pleistophorea — Order Pleistophorida

4.Phylum Sulcozoa

Subphylum Apusozoa 1/2

Class Breviatea — Order Breviatida (όχι μιτοχόνδρια)
Class Thecomonadea — Order Apusomonadida

Subphylum Varisulca 2/2

Class Diphyllatea — Order Diphylleida
Class Glissodiscea — Order Mantamonadida, Order Planomonadida
Class Hilomonadea — Order Rigifilida

Superkingdom Eukaryota

Kingdom Protozoa

A.Subkingdom **Eozoa** 1/2

1.Phylum Euglenozoa
2.Phylum Loukozoa
3.Phylum Metamonada
4.Phylum Percolozoa

B.Subkingdom **Sarcomastigota** 2/2

1.Phylum Amoebozoa
2.Phylum Choanozoa [with Microsporidia, Animalia, and Fungi constitutes "Supergroup Opisthokonta"]
3.Phylum Microsporidia [with Choanozoa, Animalia, and Fungi constitutes "Supergroup Opisthokonta"]
4.Phylum Sulcozoa

Superkingdom Eukaryota A.SUBKINGDOM **HACROBIA** 1/2

Kingdom Chromista

A.Subkingdom **Hacrobia** 1/2

1.Phylum N.N.

Class Endohelea	Order Heliomonadida [Heliozoa], Order Microhelida
Class Picomonadea	Order Picomonadida
Class Telonemea	Order Telonemida

2.Phylum Cryptophyta/Cryptista

Subphylum Palpitia

Class Palpitea

Subphylum Rollomonadia

Class Cryptophyceae	Order Cryptomonadales, Pyrenomonadales, Tetragonidiales
Class Goniomonadea	Order Goniomonadida
Class Leucocryptea	Order Katablepharida (Katablepharis), Order Palpitida

3.Phylum Haptophyta

Class Coccolithophyceae [= Prymnesiophyceae]
Order Coccolithales, Order Coccosphaerales, Order Isochrysidales
Order Phaeocystales, Order Prymnesiales, Order Syracosphaerales
Order Zygodiscales
(Isochrysis)

Class Pavlovophyceae Order Pavlovales

4.Phylum Heliozoa

Class Centrohelea Order Acanthocystida, Order Pterocystida

B.Subkingdom **Harosa**/SAR [= "Supergroup SAR"] 2/2

A.Infrakingdom **Halvaria**

I.Superphylum **Alveolata**

1.Phylum Ciliophora
2.Phylum Miozoa

II.Superphylum Heterokonta [= "Supergroup **Stramenopiles**"]

1.Phylum Bigyra
2.Phylum Ochrophyta (=Heterokontophyta)
3.Phylum Pseudofungi(=Oomycota)

B.Infrakingdom **Rhizaria**

1.Phylum **Cercozoa**
2.Phylum Retaria

Superkingdom Eukaryota B.INFRAKINGDOM **RHIZARIA** 2/2

Kingdom Chromista

A.Subkingdom Hacrobia 1/2

1.Phylum N.N., 2.Phylum **Haptophyta**, 3.Phylum **Cryptophyta**/Cryptista, 4.Phylum Heliozoa

B.Subkingdom Harosa/SAR [= "Supergroup SAR"] 2/2

A.Infrakingdom Halvaria 1/2

I.Superphylum **Alveolata**

1.Phylum Ciliophora, 2.Phylum Miozoa

II.Superphylum Heterokonta [= "Supergroup **Stramenopiles**"]

1.Phylum Bigyra, 2.Phylum Ochrophyta (=Heterokontophyta), 3.Phylum Pseudofungi(=Oomycota)

B.Infrakingdom **Rhizaria** 2/2 [Superphyla: Alveolata + Stramenopiles= A.Infrakingdom Halvaria 1/2]

1.Phylum **Cercozoa**

Subphylum Endomyxa 1/3

Class Ascetosporea	Order Claustrosporida, Haplosporida, Paradinida, Paramyxida
Class Gromiidea	Order Gromiida, Order Reticulosida
Class Phytomyxea	Order Phagomyxida, Order Plasmodiophorida (parasitic, plasmodium)
Class Vampyrellidea	Order Vampyrellida

Subphylum Monadofilosa 2/3

Class Imbricatea	
Subclass Placonuda	Order Discocelida, Order Discomonadida, Order Marimonadida, Order Euglyphida (Paulinella chromatophora), Order Variglissida
Subclass Placoperla	Order Perlofilida, Order Rotosphaerida Order Spongomonadida, Thaumatomonadida, Zoelucasida
Class Metromonadea	Order Metopiida, Order Metromonadida
Class Sarcomonadea	Order Cercomonadida, Order Glissomonadida, Order Pansomonadida Order Pseudosporida, Order Sainouroida
Class Thecofilosea	
Subclass Eothecia	Order Cryomonadida, Order Ebriida, Order Matazida, Ventricleftida
Subclass Phaeodaria	Order Eodarida, Order Opaloconchida
Subclass Tectosia	Order Tectofilosida (Chlamydophrys)

Subphylum Reticulofilosa 3/3

Class Chlorarachnea	Order Chlorarachnida
Class Granofilosea	Order Cryptofilida, Leucodictyida, Limnofilida, Desmothoracida (Heliozoa. Clathrulina), Gymnosphaerida (Heliozoa)
Class Skiomonadea	Order Tremulida

2.Phylum Retaria

I.Subphylum Foraminifera 1/2

Class Monothalamea	Order Allogromiida, Astrorhizida, Psamminida, Stannomida
Class Globothalamea	Order Carterinida, Globeriginida, Lagenida, Lituolida, Lofusiida, Order Robertinida, Rotaliida (Globerigina), Testulariida, Trochamminida
Class Tubothalamea	Order Miliolida, Order Spirillinida

II.Subphylum Radiozoa 2/2

Superclass Polycystinia	
Class Polycystinea	Order Collodarida, Order Nassellaria, Order Spumellaria
Superclass Spasmaria	
Class Acantharea	Order Arthracanthida, Order Chaunacanthida, Order Holacanthida Order Symphyacanthida
Class Sticholonchea	Order Taxopodida

Superkingdom Eukaryota I.SUPERPHYLUM **ALVEOLATA** 1/2 1.PHYLUM **CILIOPHORA** 1/2

Kingdom Chromista

A.Subkingdom Hacrobia

1. Phylum N.N., 2. Phylum Haptophyta, 3.Phylum Cryptophyta/Cryptista, 4.Phylum Heliozoa

B.Subkingdom Harosa/SAR [= "Supergroup SAR"]

A.Infrakingdom Halvaria [Rhizaria 2/2]

I.Superphylum **Alveolata** 1/2 [Stramenopiles 2/2]

1.Phylum **Ciliophora** 1/2

Subphylum Intramacronucleata 1/2

Class Armophorea	Order Armophorida, Order Clevelandellida
Class Colpodea	Order Bryometopida, Order Bryophryida, Order Bursariomorphida Order Colpodida, Order Cyrtolophosidida, Order Sorogenida
Class Litostomatea (δες τέλος)	
Subclass Haptoria	Order Cyclotrichiida, Order Haptorida (Didinium), Order Pleurostomatida
Subclass Trichostomatia	Order Entodiniomorphida, Macropodiniida, Vestibuliferida
Class Spirotrichea	
Subclass Choreotrichia	Order Tintinnida
Subclass Hypotrichia	Order Euplotida (Euplotes), Order Kiitrichida
Subclass Licnophoria	Order Licnophorida
Subclass Oligotrichia	Order Strombidiida
Subclass Protocruziidia	Order Phacodiniida, Order Protocruziida
Subclass Stichotrichia	Order Sporadotrichida, Order Stichotrichida, Order Urostylida
Class Nassophorea	Order Colpodidiida, Microthoracida, Nassulida, Synhymeniida
Class Oligohymenophorea	
Subclass Apostomatia	Order Apostomatida, Order Astomatophorida, Order Pilisuctorida
Subclass Astomatia	Order Astomatida
Subclass Hymenostomatia	Order Ophyroglenida, Order Tetrahymenida
Subclass Peniculia	Order Peniculida (Paramecium), Order Urocentrida
Subclass Peritrichia	Order Mobilida, Order Sessilida (Vorticella)
Subclass Scuticociliatia	Order Philasterida, Order Pleuronematida, Order Thigmotrichida
Class Phyllopharyngea	
Subclass Chonotrichia	Order Cryptogemmida, Order Exogemmiida
Subclass Cyrtophoria	Order Chlamydodontida, Order Dysteriida
Subclass Rhynchodia	Order Hypocomatida, Order Rhynchodida
Subclass **Suctoria**	Order Endogenida, Order Evaginogenida, Order Exogenida
Class Plagiopylea	Order Odontostomatida, Order Plagiopylida
Class Prostomatea	Order Prorodontida, Order Prostomatida

Subphylum Postciliodesmatophora 2/2

Class Heterotrichea	Order Heterotrichida (Stentor)
Class Karyorelictea	Order Loxodida, Order Protoheterotrichida, Order Protostomatida

2.Phylum **Miozoa** 2/2

Subphylum Myzozoa 1/2

A.Infraphylum **Apicomplexa**

Superclass **Sporozoa**

Subclass **Hematozoa**

B.Infraphylum **Dinozoa**

Superclass **Dinoflagellata**

Class Dinophyceae

Subphylum **Protalveolata** 2/2

Class Colponemea	Order Colponemida (Colponema)

Superkingdom Eukaryota I.SUPERPHYLUM **ALVEOLATA** 2.PHYLUM **MIOZOA** 2/2

Kingdom Chromista

A.Subkingdom Hacrobia

B.Subkingdom Harosa/SAR [= "Supergroup SAR"]

A.Infrakingdom Halvaria

I.Superphylum **Alveolata**

1.Phylum **Ciliophora**

2.Phylum **Miozoa**

Subphylum **Myzozoa** 1/2

A.InfraphylumΑνθυποφύλο **Apicomplexa (Phylum)**

Superclass Apicomonada 1/2

Class Apicomonadea

Subphylum **Protalveolata** 2/2

B.Infraphylum **Dinozoa**

1.Order Chromerida, (Chromera velia, Vitrella)

2.Order Colpodellida, (Colpodella), Order Voromonadida

Superclass **3**.Sporozoa 2/2

Class N.N. 1/4 — Order Blastogregarinida,

Class **Gregarino**morphea [Class Conoidasida;= Coccidia + Gregarina] 2/4

Subclass Cryptogragaria — Order Cryptogregarida

Subclass Histogregaria — Order Histogregarida

Subclass Orthogregarinia — Order Arthrogarida, Order Vermigregarida

Class Paragregarea 3/4 — Order Archigregarinida, Order Stenophorida, Order Velocida

Class Coccidiomorphea [Class Conoidasida;= Coccidia+ Gregarina] 4/4

Subclass **Coccidea** — Order Agamococcidida, Order Eimerida (Eimeria, Cryptosporidium parvum), Order Ixorheida [Toxoplasma gondii]

Subclass Coleotrophia — Order Coleotrophiida [= Protococciida]

Subclass **Hematozoa** — [Aconoidasida/Aconoasida] [Conoid present only in the ookinete of some species]

Superorder Aconoidia — Order Nephromycida[όχι παράσιτα], Order Piroplasmida (Babesia, Theileria) παράσιτο, without a conoid

Superorder Haemosporidia (χωρίς κώνο) Ookinete has a conoid — Order Hemosporida [Plasmodium falciparum, Leucocytozoon]

B.Infraphylum Dinozoa

Superclass Dinoflagellata **1/2**

Class Dinophyceae

Subclass N.N. — Order Actiniscales, Blastodinales, Coccidinales, Dinamoebales, Order Lophodinales Order Pyrocystales, Order Thoracosphaerales

Subclass Dinophysoidia — Order Dinophysidales, Order Nannoceratopsales

Subclass Gonyaulacoidia — Order Gonyaulacales (Gonyaulax), Order Gymnodiniales (Gymnodinium)

Subclass Peridinoidia — Order Peridiniales, Order Prorocentrales

Subclass Suessioidia — Order Suessiales

Class Ellobiopsea — Order Ellobiopsida

Class Noctilucea — Order Noctilucida (Noctiluca)

Class Oxyrrhea — Order Acrocoelida (Acrocoelus), Order Oxyrrhida (Oxyrrhis)

Class Syndinea — Order Rastrimonadida, Order Syndinida

Superclass Perkinsozoa **2/2**

Class Myzomonadea — Order Algovorida

Class Perkinsea — Order Perkinsida (Perkinsus), +(Parvilucifera, Cryptophagus/Rastrimonas) Order Phagodinida