The Entomology & Nematology Comprehensive Examinations consist of 3 sections: pest identification (30%), pest biology and management (40%), and core concepts and synthesis (30%). These examinations are limited to information about invertebrate animal pests, principally insects and nematodes, but also plant feeding mites and terrestrial molluscs.

A. Pest identification
Students will be presented with insects, mites, molluscs, and nematodes that they must identify. Some may be recognizable by sight, but others may require keys for identification. Students will be provided with identification aids (keys), where necessary, and be expected to use them to identify the subjects accurately. The unknowns will be selected from the list of important insect, mite, mollusc, and nematode pests (Table 1) though we will emphasize those with a single or double asterisk [* or **], as these normally are the more important pests. Included in this list are some that pose a threat but are not currently found in Florida.

B. Pest biology and management
Students will answer 8-10 questions on insect, mite, mollusc, and nematode pest biology (sampling, distribution, life cycle, damage) and management. The animals for which students are responsible to know biology and management are listed in Table 1 (preceded by double asterisk [**]).

C. Core Concepts and Synthesis Section:
Students will answer 3 or 4 questions that cover core areas of Entomology/Nematology and demonstrate knowledge of core areas, but also analysis and problem solving. Suggested reference/reading material is listed in Table 2. You might want to read through these in preparation for the Comprehensive Examinations.

Diagnostic material for Part A will be provided during the exam. Students will not have access to the internet or cell phones during the exam. Written answers will be entered onto a laptop computer, provided at the testing site. The nematology examination is separate from the entomology/acarology/malacology test; each test is limited to an 8-hour period. All testing must be completed by the end of the test period.

CORE COMPETENCY AREAS FOR THE DOCTOR OF PLANT MEDICINE PROGRAM

1. Pest identification
   a. Processes and procedures for identification
   b. Ability to use diagnostic keys
c. Sources of information that serve as an aids in identification
d. Important morphology and anatomy used in identification
e. Characteristics of orders and important families

2. Pest biology
   a. How these animal pests are organized structurally
   b. How these animal pests function physiologically
   c. Signaling among animals
   d. How these animal pests interact with the biotic and physical environment
   e. The life cycles of these animals
   f. Temperature effects on insect development (including degree days)

3. Pest population biology
   a. Environmental factors affecting animal abundance
   b. Natural enemies affecting animal abundance
   c. Host plant effects on animal abundance
   d. Life tables and key factor analysis
   e. Factors affecting spatial distribution
   f. Pesticide effects on animal abundance
   g. Invasiveness of animals (including eradication, quarantine, interception, and history of invasion)

4. Animal-plant interactions and problem identification
   a. How plants are affected by animals
      i. Types of damage
      ii. Disease transmission
      iii. Damage thresholds & economic injury levels
      iv. Pollination
   b. Plant defenses against herbivory
      i. Host range & feeding behavior
      ii. Chemical
      iii. Structural
      iv. Compensatory growth
      v. Biotechnology

5. Beneficial organisms
   a. Predators
   b. Parasitoids
   c. Disease-causing organisms

6. Principles and tactics of pest management
   a. Sampling, monitoring, and forecasting
   b. Site-specific and area-wide management (including SIT)
   c. Cultural & interference methods of management
      i. Modifying the physical environment
      ii. Cropping practices
      iii. Host plant resistance
      iv. Semiochemicals
      v. Sterility
   d. Biological methods of management
      i. Conservation
ii. Augmentative
iii. Introduction/classical
e. Chemical methods of management
   i. Classification
   ii. Mode of action & metabolism
   iii. Safety & regulations
   iv. Environmental/nontarget effects
   v. Methods of formulation & application
   vi. Methods of evaluation
   vii. Resistance management
7. Management based on regulations
8. Experimental design and analysis
   i. Observations (e.g., categorical, discrete)
   ii. Hypothesis testing
   iii. P-values & significance levels
   iv. Controls, sample size & replication
   v. Descriptive statistics (e.g., mean, median, mode, range)
   vi. Displaying data (e.g., SD, SE, CI, box plots, scatter plots, trend lines, columns, plotted lines)
   viii. Tests of difference (e.g., unpaired t-test, paired t-test, Mann-Whitney test, Wilcoxon signed ranks test, one-way ANOVA, two-way ANOVA, Kruskal-Wallace test, Friedman's test, interactions, repeated measures)
   ix. Tests of relationship & frequency (e.g., correlation, regression, Chi-square & Fishers test)
   x. Other (e.g., data transformation, outliers, parametric versus non-parametric tests, homogeneity of variance, normality tests, post-hoc/multiple comparison tests)
   xi. Standard experimental designs (e.g., random, randomized complete block, Latin square)
   xii. Sampling (e.g., absolute & relative methods, sequential sampling, dispersion, diversity, habitat description)

Table 1. Invertebrate animal pests of importance to Florida, and their hosts

(* = important plant pests)
(** = consistently important plant pests)
(#) not presently occurring in Florida)

(host relationship/importance is:
  A = animals and humans;
B = beneficial;
FR = fruit or berry crop;
FC = field crops;
G = turf or forage grass;
N = nuisance or contaminant;
T = tree;
O = ornamental plant;
S = stored products;
V = vegetable crops;
W = wood.)

**BEETLES**

*Banded cucumber beetle, *Diabrotica balteata* LeConte; **

**Yellow-margined leaf beetle, *Microtheca ochroloma* Stal; **

**Pepper weevil, *Anthonomus eugenii* Cano; **

*White-fringed beetle, *Naupactus (=Graphognathus) spp.; **

**White grubs, *Phyllophaga* spp.; **

**Southern pine bark beetle, *Dendroctonus frontalis* Zimmermann; **

**Diaprepes root weevil, *Diaprepes abbreviatus* (Linnaeus); **

*Citrus root weevils (southern citrus root weevil, *Pachnaeus litus*; northern citrus root weevil, *Pachnaeus opalus*; little leaf notcher, *Artipus floridanus*); **

*Mexican bromeliad weevil, *Metamasius callizona* (Chevrolat); **

**Asian grey weevil, *Myllocerus undatus* (Marshall); **

*Hunting billbug, *Sphenophorus venatus* Chittenden; **

**Palmetto weevil, *Rhynchophorus cruentus* Fabricius; **

*Twig girdler, *Oncideres cingulata* (Say); **

*Black twig borer, *Xylosandrus compactus* (Eichhoff); **

Mexican bean beetle, *Epilachna varivestris* Mulsant; **

**Colorado potato beetle, *Leptinotarsa decemlineata* (Say); **

Striped cucumber beetle, *Acalymma vittatum* (Fabricius); **

Southern corn rootworm, *Diabrotica undecimpunctata* (Barber); **

Banded cucumber beetle, *Diabrotica balteata* LeConte; **

# Western corn rootworm, *Diabrotica virgifera* LeConte; **

Green June beetle, *Cotinus nitida* (Linnaeus); **

Sawtoothed grain beetle, *Oryzaephilus surinamensis* (Fitch); **

Drugstore beetle, *Stegobium panicum* (Linnaeus); **

Cigarette beetle, *Lasioderma serricorne* (Fabricius); **

Pales weevil, *Hylobius pales* (Herbst); **

*Redbay ambrosia beetle, *Xyleborus glabrat us* Eichhoff; **

# Asian longhorned beetle, *Anoplophora glabripennis* (Motschulsky); **

# Emerald ash borer, *Agrilus planipennis* Fairmaire; **

# Japanese beetle, *Popillia japonica* Newman; **

Asian ladybird beetle, *Harmonia axyridis* (Pallas); **
FLIES
**American serpentine leafminer, Liriomyza trifolii (Burgess); V, O, FC
**Cornsil fly, Euxesta stigmata Loew; V
**Caribbean fruit fly, Anastrepha suspensa (Loew); FR
# Medfly, Ceratitis capitata (Weidemann); FR
# Oriental Fruit fly, Bactrocera dorsalis Hendel; FR, V
*Spotted wing drosophila, Drosophila suzukii (Matsumura); FR
*Darkwinged fungus gnats, Bradysia spp.; O, V
Asian tiger mosquito, Aedes albopictus (Skuse); A
Florida SLE mosquito, Culex nigripalpus Theobald; A
Black salt-marsh mosquito, Ochlerotatus taeniorynchus; A
Eastern salt-marsh mosquito, O. sollicitans (Walker); A
Common malaria mosquito, Anopheles quadrimaculatus Say; A
Dark ricefield mosquito, Psorophora columbiae (Dyar & Knab); A
Floodwater mosquito, Coquilletidia perturbans (Walker); A
Stable fly, Stomoxys calcitrans (Linnaeus); A
Deer flies, Chrysops spp. and others; A
Horse flies, Tabanus spp. and others; A
Moth flies, Psychoda spp.; N
House fly, Musca domestica Linnaeus; N
Humpbacked or Phorid flies; N
Soldier flies; B, N
Lovebug, Plecia nearctica Hardy; N

BUGS, ETC.
**Leaf-footed bug, Leptoglossus phyllopus (Linnaeus); V, O, FC, FR
**Squash bug, Anasa tristis (DeGeer); V
**Lantana lace bug, Teleonemia scrupulosa Stal; O
**Garden fleahopper, Halticus bractatus (Say); V
**Glassywinged sharpshooter, Homalodisca coagulata (Say); FR, O
**Jadera bug, Jadera haemataloma (Herrich-Schaeffer); T
*Twolined spittlebug, Prosapia bicincta (Linnaeus); G
**Southern chinch bug, Blissus insularis Barber; G
*Brown stink bug, Euschistus servus (Say); FC, FR, V
**Southern green stink bug, Nezara viridula (Linnaeus); V, O, FC, FR
*Harlequin bug, Murgantia histrionica (Hahn); V
**Silverleaf whitefly, Bemisia argentifolii Bellows and Perring; FC, O, V
*Citrus whitefly, Dialeurodes citri (Ashmead); FR
*Cloudywinged whitefly, Dialeurodes citrifolii (Morgan); FR
**Rugose spiraling whitefly, Aleurodicus rugiopercolatus Martin; O, FR, T
*Citrus blackfly, Aleurocanthus woglumi Ashby; FR
**Cabbage aphid, Brevicoryne brassicae (Linnaeus); V
**Green peach aphid, Myzus persicae (Sulzer); O, FC, V, FR
**Melon aphid, Aphis gossypii Glover; FC, FR, V, O
*Potato aphid, Macrosiphum euphorbiae (Thomas); V, O
**Brown citrus aphid, Toxoptera citricida (Kirkaldy); FR, O
**Pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green); O
*Papaya mealybug, *Paracoccus marginatus* Williams; FR, O
**Longtailed mealybug, *Pseudococcus longispinus* (Targioni-Tozzetti); FR, O, T
**Madiera mealybug, *Phenacoccus madeirensis* Green; O, V
**Citrus mealybug, *Planococcus citri* (Risso); O, FR, V
**Cycad aulacaspis scale, *Aulacaspis yasumatsui* Takagi; O, T
**Citrus psyllid, *Diaphorina citri* Kuwayama; FR
**Tea scale, *Fiorinia theae* Green; O, T
*Citrus snow scale, *Unaspis citri* (Comstock); FR
*False oleander scale, *Pseudaulacaspis cockerelli* (Cooley); O, T
**White peach scale, *Pseudaulacaspis pentagona* (Targioni-Tozzetti); O, T
**Green scale, *Coccus viridis* (Green); O, T
**Florida wax scale, *Ceroplastes floridensis* (Comstock); O, T, FR
**Florida red scale, *Chrysolinae aonidum*; T, FR, O
**Hemispherical scale, *Saissetia coffeae* (Walker); O, FR
**Pyrimidal scale, *Protopulvinaria pyriformis* (Cockerell); FR, O
**Cottonty cushion scale, *Icerya purchasi* Maskell; FR
**Lobate lac scale, *Paratrichardina lobata* (Chamberlin); O, T
# Brown marmorated stink bug, *Halyomorpha halys* Stal; FR, FC
# Bagrada bug, *Bagrada hilaris* (Burmeister); V, FC, F
Bed bug, *Cimex lectularius* Latreille; A

**ANTS, BEES, ETC.
**Red imported fire ant, *Solenopsis invicta* Buren; A, N, V, FC
**Tawny crazy ant, *Nylanderia fulva* (Mayr); N
Florida carpenter ant, *Camponotus floridanus* (Buckley); N
Pharaoh ant, *Monomorium pharaonis* (Linnaeus); N
Acrobat ant, *Crematogaster ashmeadi* (Emery); N
Whitefooted ant, *Technomyrmex albipes* (Fr. Smith); N
*Elongate twig ant, *Pseudomyrmex gracilis* (Fabricius); A, N
Carpenter bee, *Xylocopa virginica* (Linnaeus); W
Honey bee, *Apis mellifera* Linnaeus; B, N
Cicada killer, *Sphecius speciosus* (Drury); B, N
Bumble bees; *Bombus* spp.; B
Honey bee; *Apis mellifera*; B
Paper wasps, *Polistes* spp.; B, N

**MOTHS AND BUTTERFLIES
**Citrus leafminer, *Phyllocnistis citrella* Stainton; FR
**Corn earworm, *Helicoverpa zea* Boddie; FC, FR, O
*Velvetbean caterpillar, *Anticarsia gemmatalis* Hübner; FC
*Azalea caterpillar, *Datana major* Grote & Robinson; O
**Oleander caterpillar, *Syntomeida epilais* Walker; O
*Eastern tent caterpillar, *Malacosoma americanum* (Fabricius); T, N
*Forest tent caterpillar, *Malacosoma disstria* Hübner; T
*Fall webworm, Hyphantria cunea (Drury); T
*Tussock moths, Orgyia detrita, Orgyia leucostigma, and Orgyia definite; T
*Cabbage palm caterpillar, Litoprosopus futilis (G. & R.); T
*Palm leaf skeletonizer, Homaledra sabalella (Chambers); T
**Bean leafroller, Urbanus proteus (Linnaeus); V
**Beet armyworm, Spodoptera exigua (Hübner); FC, V
**Fall armyworm, Spodoptera frugiperda (J. E. Smith); G, FC, V
*Cabbage looper, Trichoplusia ni (Hubner); V, FC, O
*Granulate cutworm, Agrotis subterranea (Fabricius); FC, V, O
**Armyworm, Pseudaletia unipuncta (Haworth); FC, V
**Southern armyworm, Spodoptera eridania (Cramer); FC, O, V
**Yellowstriped armyworm, Spodoptera ornithogalli (Guenée); FC, V
**Imported cabbageworm, Pieris rapae (Linnaeus); V
**Diamondback moth, Plutella xylostella (Linnaeus); V
**Tropical sod webworm, Herpetogramma phaeopteralis Guenée; G
**Lesser cornstalk borer, Elasmopalpus lignosellus (Zeller); FC, V
**Melonworm, Diaphania hyalinata (Linnaeus); V
**Pickleworm, Diaphania nitidulis (Stoll); V
*Tobacco hornworm, Manduca sexta Linnaeus; V, FC
**Grape root borer, Vitacea polistiformis (Harris); FR
*Florida fern caterpillar, Callopistria floridensis Guenée; O
Oakworms, Anisota spp; T
Oak leafrollers, Archips semiferana (Walker); T
Carpenterworm, Prionoxystus robiniae (Peck); T
Saddleback caterpillar, Sibine stimulae (Clemens); T, A
Puss caterpillar, Megalopyge opercularis (J.E. Smith), A
White flannel moth caterpillar, Orape ovina (Sepp); T, A
Io moth, Automeris io (Fabricius); O, A
Orangedog, Papilio cresphontes Cramer; F
Indian meal moth, Plodia interpunctella (Hübner); S
Household casebearer (Plaster bagworm), Phereoeca uterella Walsingham; N

GRASSHOPPERS AND CRICKETS
**American grasshopper, Schistocerca americana (Drury); FR, T, O, G
**Eastern lubber grasshopper, Romalea guttata (Houttuyn); FR, T, O, G
**Southern mole cricket, Scapteriscus borellii Giglio-Tos; G
**Tawny mole cricket, Scapteriscus vicinus Scudder; G

WALKINGSTICKS
Twostriped walkingstick, Anisomorpha buprestoides (Stoll); N

PSOCIDS
Bark lice; N
Book lice; N
Grain psocid, Lachesilla pedicularia (Linnaeus); S
COCKROACHES
American cockroach, Periplaneta americana (Linnaeus); N
Asian cockroach, Blattella asahinai Mizukobo; N
German cockroach, Blattella germanica (Linnaeus); N
Florida woods cockroach, Eurycotis floridana (Walker); N

FLEAS
Cat flea, Ctenocephalides felis Bouché; A

TERMITEs
Eastern subterranean termite, Reticulitermes flavipes (Kollar); W
Formosan termite, Coptotermes formosanus Shiraki; W
Drywood termites; W

THRIPS
**Western flower thrips, Frankliniella occidentalis (Pergande); O, V, FC
**Melon thrips, Thrips palmi Karny; V
**Florida flower thrips, Frankliniella bispinosa (Morgan); FR, FC, V
*Cuban laurel thrips, Gynaikothrips ficorum (Marchal); O
**Chilli thrips, Scirtothrips dorsalis Hood; O, V

MITES
**Broad mite, Polyphagotarsonemus latus (Banks); V
**Twospotted spider mite, Tetranychus urticae Koch; O, V, FC, FR
*Tomato russet mite, Aculops lycopersici (Massee); V
**Citrus rust mite, Phyllocoptruta oleivora (Ashmead); FR
*Red palm mite, Raoiella indica Hirst; 2:55 PM, O, FR

TICKS
Lone star tick, Amblyomma americanum (Linnaeus); A
Brown dog tick, Rhipicephalus sanguineus (Latreille); A
Blacklegged tick, Ixodes scapularis Say; A

NEMATODES
**Root-knot nematodes, Meloidogyne incognita, M. javanica, M arenaria, M. hapla; V
**Soybean cyst nematode, Heterodera glycines; FC
**Citrus nematode, Tylenchulus semipenetrans; FR
**Reniform nematode, Rotylenchulus reniformis; FC, V
**Lesion nematode, Pratylenchus; FC, O, F
**Burrowing nematode, Radopholus; FR
**Sting nematode, Belonolaimus; G, FR, V
**Lance nematode, Hoplolaimus; G, O
**Spiral nematode, Helicotylenchus; G
**Ring nematode, Mesocriconema; G
**Dagger nematode, Xiphinema; G, FR, O
**Awl nematode, Dolichodorus; G, FR, O, V
**Stubby nematode, Trichodorus/Paratrichodorus; G, O, V  
**Stunt nematode, Tylenchorhynchus; G, FC, V

MOLLUSCS

**Cuban brown snail, Zachrysia provisoria (L. Pfeiffer); O, V  
*Perforate dome snail, Ventridens demissus (A. Binney); O, V  
Giant African Snail, Lissachatina (Achatina) fulica (Férussac); O, T, N  
*Asian tramp snail, Bradybaena similaris (Férussac); O, V, FR  
*Florida leatherleaf slug, Leiydula floridana (Leidy); O  
**Marsh slug, Deroceras laeve (Müller); O, V

Table 2. Suggested readings and references

Pest identification

Borrer, Triplehorn and Johnson, An Introduction to the Study of Insects  
Cranshaw, Garden Insects of North America  
Potter, Destructive Turfgrass Insects  
Evans, Beetles of Eastern North America  
Miller and Johnson, Armored Scale Insect Pests of Trees and Shrubs  
Johnston and Lyon, Insects that Feed on Trees and Shrubs  
Capinera, Handbook of Vegetable Pests  
Stehr, Immature Insects  
Wagner, Caterpillars of Eastern North America  
Wagner et al., Owlet Caterpillars of Eastern North America

Pest biology

Whitfield and Purcell, Introduction to Insect Biology and Diversity  
Pedigo and Rice, Entomology and Pest Management  
Cranshaw and Redak, Bugs Rule!  
Speight, Hunter, and Watt, Ecology of Insects  
Schowalter, Insect Ecology, An Ecosystem Approach  
Hull, Matthews' Plant Virology, 4th edition  

Pest management

Pedigo and Rice, Entomology and Pest Management  
Van Emden and Service, Pest and Vector Control
Thacker, An Introduction to Arthropod Pest Control
Dent, Insect Pest Management
Hoy, Agricultural Acarology: Introduction to integrated mite management
Halbert, Management of Insect-Vectored Pathogens of Plants. in J. L. Capinera, ed.
    London B 353: 1787- 1795. Available at:

Experimental design and analysis
    Southwood, Ecological Methods
    Krebs, Ecological Methodology
    Gotelli and Ellison, A Primer of Ecological Statistics
    Dytham, Choosing and Using Statistics, A Biologist’s Guide
    Motulsky, Intuitive Biostatistics, A Nonmathematical Guide to Statistical Thinking