Chapter 12: Arthropoda  (Greek=jointed foot/appendage)

75% of all described species

>1,100,000 species described >1,000,000 species still undescribed

rich fossil history dating to the late Precambrian >600 mya

size ranges: Japanese crab (4 m leg span)  follicle mite (0.1 mm long)

abundance/wide ecological distribution  most diverse animal group

serious disease agents & compete with humans for food; others beneficial

all feeding modes: but most herbivorous
General Arthropodan Characteristics

1) exoskeleton
2) eucoelomate protostomes with well-developed organ systems
3) similar to annelids → distinct segments
   a) molecular analyses: annelids & arthropods from different ancestor
   b) primitive pattern: linear series of somites with jointed appendages
   c) many somites fused(combined into specialized groups → tagmata
   d) appendages often highly specialized for division of labor

Arthropodan Evolution

1) ancestral arthropodan soft cuticle:
   stiffened by deposition of protein & inert polysaccharide chitin
2) joints provide flexibility:
   sequence of molts necessary to allow for growth
3) molting required hormonal control
4) hydrostatic skeleton function lost:
   coelom regressed; open sinuses replaced them
5) motile cilia lost
6) if this not a monophyletic group:
   these features would all have to arise independently
7) exoskeleton: cuticle highly protective but jointed for mobility
**Segmentation & Appendages for Efficient Locomotion**

1) usually each somite →
   - pair of jointed appendages

2) segments & appendages modified for various adaptive functions

3) limb segments:
   - hollow levers with internal striated muscles

4) function
   - a) sensing
   - b) food handling
   - c) walking
   - d) swimming

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**Modern Exoskeleton**

1) procuticle lightweight, flexible → protection against dehydration

2) chitin: 40% of the procuticle in insects: 80% in crustaceans

3) impregnation with calcium salts: procuticle very hard in lobsters/crabs

4) cuticle: laminated & further hardened by a chemical tanning process

5) cuticle thin between segments → allows movement at joints

6) cuticle folds inward to line the foregut, hindgut & trachea

7) molting (ecdysis): process of shedding old exoskeleton & replacing with a larger one

8) typically molt 4 to 7 times: weight limit to ultimate body size
Exoskeleton

1) outer thin **epicuticle**
2) inner thick **procuticle**
   a) **exocuticle** secreted before a molt
   b) **endocuticle** secreted after molting
   c) both layers contain **chitin** bound with protein

Molting Hormone (MH)
X organ-sinus gland → Molt-Inhibiting Hormone (MIH) peptide 4000-5000 MW

Y-organ: Molting Hormone

Molting Hormone Titers

Ecdysteroid Conc. (pg/µl)

Time (d)
Phylum: Arthropoda

Subphylum: Trilobitomorpha
  Class: Trilobita
Subphylum: Chelicerata
  Class: Merostomata
  Class: Arachnida
  Class: Pycnogonida
Subphylum: Crustacea
  Class: Maxillopoda
    Subclass: Copepoda
    Subclass: Cirripedia
  Class: Branchiopoda
Subphylum: Uniramia
  Class: Chilopoda
  Class: Diplopoda
  Class: Hexapoda
Phylum: Arthropoda
Subphylum: Trilobitomorpha
Class: Trilobita (no living species)
4,000 spp. fossil records
before Cambrian >600 mya; common 500 mya
extinct 250 mya; end of Paleozoic

Subphylum: Chelicerata (claw) 75,000 spp
Cheliceratan Characteristics
1) 6 pairs of cephalothoracic appendages
   a) chelicerae
   b) pedipalps
   c) four pair of legs
2) lack mandibles & antennae
3) most suck liquid food from prey
**Subphylum: Chelicerata**

**Class: Merostomata** (extinct except for 4 spp)

- **eurypterid (3 m)**
  - Cambrian ➔ Permian
  - 570———245 mya

- **horseshoe crab (3 m) *Limulus***
  - Triassic 245-208 mya

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*Figure 18.02b*
**Subphylum: Chelicerata**  
**Class: Arachnida** (Greek: spiders) 74,000 spp ancestors → marine

50% spiders

1400 scorpions

40000 mites & ticks
Other Characteristics
- Uniformly light-colored legs - no stripes, no bands
- Uniformly colored abdomen: vary from cream to dark brown (dependent on food)
- Never have two colors of pigment at the same time.
- No spines on the legs, only fine hairs
- Small retreat webs behind objects, never out in open
- Body length ~3/8 inch

Hobo spider

Characteristics
- Legs show no distinct rings and have short hairs.
- Abdomens several chevron shaped markings
- Males: two large palps that look like boxing gloves
- Palps mistaken for fangs or venom sacs, but are male genitalia
- Females: palps, but the ends are not 'swollen' like males
- Females larger abdomen when compared to males
- Body length: ~12 to 18 mm
**Class: Pycnogonida** (Greek = thick knees or all legs)  
(sea spiders) 1000 spp
Chelicerata

Pycnogonida
- Multiple gonopores
- Abdomen reduced
- Preoral proboscs
- Ovigers

Merochomata
- Tetson
- Book gills
- Abdominal appendages reduced, lost, or modified
- 1st or 2nd abdominal somite modified as genital somite
- Two median eyes
- Cephalothorax a carapace-like shield

Arachnida
- Silt sensilla
- Loss of antennae
- Four pairs of legs
- Chelicerae and pedipalps
- Cephalothorax and abdomen