(a) Autocrine action  
Paracrine action

(b) Neurone
Stimulus induces
(1) permeability increase
(2) $\text{Na}^+$, $\text{Ca}^{2+}$ influx
(3) depolarization

Secretion follows
(1) depolarization
(2) permeability increase
(3) $\text{Ca}^{2+}$ influx

(c) Neurosecretory cell

Endocrine action

Bloodstream

Hormone molecules

Target cells

(c) Simple endocrine cell

ER
$\text{Ca}^{2+}$

Capillary
Efecto hormonal (%)

100

50

Umbral

Concentración hormonal

Respuesta máxima

Sensibilidad
(mitad de la concentración máxima)

↓ Respuesta máxima

↓ Sensibilidad

Concentración hormonal
### Table 9-5  Comparison of lipid-soluble and lipid-insoluble hormones

<table>
<thead>
<tr>
<th>Property</th>
<th>Lipid-soluble</th>
<th>Lipid-insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Steroids</td>
<td>Thyroid hormones</td>
</tr>
<tr>
<td>Feedback regulation of synthesis</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Binding to carrier proteins</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lifetime in blood plasma</td>
<td>Hours</td>
<td>Days</td>
</tr>
<tr>
<td>Time course of action</td>
<td>Hours to days</td>
<td>Days</td>
</tr>
<tr>
<td>Receptor location</td>
<td>Cytosolic or nuclear</td>
<td>Nuclear</td>
</tr>
<tr>
<td>Mechanism of action</td>
<td>Receptor-hormone complex stimulates or inhibits gene expression</td>
<td>Hormone binding triggers second-messenger or activates intrinsic catalytic activity</td>
</tr>
</tbody>
</table>

Source: Adapted from Smith et al., 1983, p. 355. Used with permission of McGraw-Hill.
(b) Convergent pathway

Epinephrine

α

Ca^{2+}

Phosphorylase kinase

Glycogenolysis

Mammalian liver

Receptor

G protein

Adenylate cyclase

ATP
cAMP

(b) Divergent pathway

Epinephrine

α

Ca^{2+}

ATP
cAMP

Fluid secretion

Amylase release

Mammalian salivary gland
Neural Reflex Arc

(i) Stimulus → Sense organ → Central nervous system → Motoneuron → Action potential → Effector organ → Response

First Order Neuroendocrine Loop

(ii) Stimulus → Sense organ → CNS → Neuro-hormone → Target effector organ → Response

Second Order Neuroendocrine Loop

(iii) Stimulus → Sense organ → CNS → Action potential → Neuro-hormone → Endocrine gland → Hormone → Target effector organ → Response

Third Order Neuroendocrine Loop

(iv) Stimulus → Sense organ → CNS → Neuro-hormone → Endocrine gland → Hormone$_1$ → Endocrine gland → Hormone$_2$ → Target effector organ → Response

Direct Endocrine Loop

(v) Stimulus → Endocrine gland → Target effector organ → Response

Cells in brain and eyestalk (X-organ)

Cells in brain

Cells in hypothalamus

- Crustacean
- Insect
- Amphibian

- y-o
- sg
- int
- cc
- pro
- me
- pv
- ah
- n.h
- tg
- int
1. Environmental variables and time signals
   Temperature  Daylength  Food  Specific chemistry

2. Perception of signals
   Central nervous system
   Long versus short days
   Temperature
   Tidal & lunar information
   Phase relationships

3. Integration and summation
   Neuroendocrine system
   TRANSDUCTION

4. ENDOCRINE OUTPUT
   Gamete proliferation
   Gamete development
   Gamete discharge

5. Observed cycle of gamete production and discharge
Somatic growth

Reproductive growth
MIH → SG

Neurosecretory Neuron +

Serotonergic Neuron +

Environmental Inputs +

Eyestalk Ganglia

20-hydroxyecdysone

MIH

R

AC

ATP → cAMP

Ca → 5' AMP → ecdysone

Y-organ

cholesterol

PDE activity (pmol cAMP hydrolyzed/minute)

Molt stage

Pre-ecdysone

**

Middle pre-ecdysone

Late pre-ecdysone

Post-ecdysone
A. ADRENALCORTICAL CELL

B. Y-ORGAN CELL
JH-sensitive period for pigmentation

Presynthetic phase
(cell division, morphogenesis)

Commitment
(JH sensitive period for type of molt)

PTTH release

Sclerotization
(bursicon)

New cuticle synthesis

Ecdysis
(ETH, EH, CCAP)

Figure legend

CCAP = crustacean cardioactive peptide
EH = ecdision hormone
ETH = ecdysis-triggering hormone
JH = juvenile hormone
Ecdisona, otros estimulos

EG=epitracheal glands

ETH=ecdysis triggering hormone

Cerebro

EH=eclosion hormone

Cadena nerviosa ventral

CCAP=crustacean cardioactive peptide

Ecdysis
Table 2-1  Some of the known insect hormones, their sources, functions, and chemical type

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Source</th>
<th>Function</th>
<th>Chemical type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecdysteroids</td>
<td>Prothoracic gland</td>
<td>Initiation of molting and egg maturation</td>
<td>Steroid</td>
</tr>
<tr>
<td>Prothoracicotropic hormone (PTTH)</td>
<td>Brain</td>
<td>Control of ecdysteroid production</td>
<td>Peptide</td>
</tr>
<tr>
<td>Bombyxin</td>
<td>Brain</td>
<td>Ecdysteroid production, carbohydrate metabolism</td>
<td>Peptide</td>
</tr>
<tr>
<td>Ecdysis-triggering hormone (ETH)</td>
<td>Epitracheal gland</td>
<td>Ecdysis behavior</td>
<td>Peptide</td>
</tr>
<tr>
<td>Eclosion hormone (EH)</td>
<td>Brain</td>
<td>Ecdysis behavior</td>
<td>Peptide</td>
</tr>
<tr>
<td>Crustacean cardioactive peptide (CCAP)</td>
<td>Ventral nerve ganglia</td>
<td>Ecdysis behavior, heart rate modulation</td>
<td>Peptide</td>
</tr>
<tr>
<td>Bursicon</td>
<td>Brain and ventral nerve ganglia</td>
<td>Tanning of cuticle</td>
<td>Peptide</td>
</tr>
<tr>
<td>Juvenile hormone (JH)</td>
<td>Corpora allata</td>
<td>Regulation of metamorphosis and reproduction</td>
<td>Terpenoid</td>
</tr>
<tr>
<td>Allatostatin</td>
<td>Brain</td>
<td>Inhibition of JH production</td>
<td>Peptide</td>
</tr>
<tr>
<td>Allatropin</td>
<td>Brain</td>
<td>Stimulation of JH production</td>
<td>Peptide</td>
</tr>
<tr>
<td>Adipokinetic hormone (AKH)</td>
<td>Corpora cardiaca</td>
<td>Fat (energy) metabolism</td>
<td>Peptide</td>
</tr>
<tr>
<td>Hypertrehalosemic hormone</td>
<td>Corpora cardiaca</td>
<td>Control of sugar metabolism</td>
<td>Peptide</td>
</tr>
<tr>
<td>Diuretic hormone (DH)</td>
<td>Brain, corpora cardiaca, ventral ganglia</td>
<td>Water balance and urine production</td>
<td>Peptide</td>
</tr>
<tr>
<td>FMRFamides</td>
<td>Central nervous system</td>
<td>Neuromodulators, myosuppression</td>
<td>Peptide</td>
</tr>
<tr>
<td>Diapause hormone</td>
<td>Brain, subesophageal ganglion</td>
<td>Initiation of diapause in embryos</td>
<td>Peptide</td>
</tr>
<tr>
<td>Pheromone biosynthesis activating neuropeptide</td>
<td>Subesophageal ganglion</td>
<td>Initiates pheromone production</td>
<td>Peptide</td>
</tr>
</tbody>
</table>

1 Not intended to be a comprehensive list
Insectos

Células neurosecretorias del pars intercerebral

Transporte axonal

Sistema nervioso central

Estímulos

Células neurosecretorias del órgano X

Transporte axonal

Crustáceos

Cuerpos cardíacos

Hormona toracotrófica

Glándula torácica

Ecdisona

Ecdisona

Larva

Pupa

Adult

JH concentration

Stage of development