# Neuroendocrinology 신경내분비학

항상성을 유지하기 위해 신체 기능을 조절하는 신경계와 내분비계의 상호작용

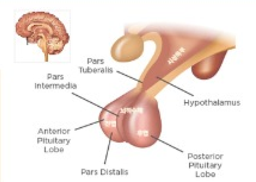
**Hypothalamus** 시상하부

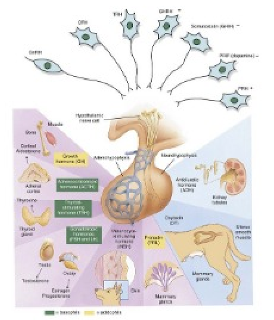
신경내분비세포(neuroendocrine cells)가 호르몬 분비
- Corticotropin-releasing hormone (**CRH**)
- Thyrotropin-releasing hormone (**TRH**)
- Growth hormone-releasing hormone (**GHRH**)
- **Somatostatin**: growth hormone-inhibiting hormone
- Gonadotropin-releasing hormone (**GnRH**)
- **Dopamin**: major prolactin inhibiting hormone

Hypothalamic Nerve cell — Hypophyseal Portal System

**Posterior Pituitary** 뇌하수체 후엽
*Neurohypopysis = pars nervosa*
- **Vasopressin** (항이뇨호르몬) = antidiuretic hormone(ADH), arginine vasopressin(AVP)
- **Oxytocin** (자궁수축 호르몬)

**Anterior Pituitary** 뇌하수체 전엽
*Adenohypopysis = pars distalis*
- Thyrotrophs: thyroid-stimulating hormone (**TSH**)
- Corticotrophs: adrenocorticotropic hormone (**ACTH**)
- Gonadotrophs: luteinizing hormone (**LH**), follicle-stimulating hormone (**FSH**)
- Somatotrophs: growth hormone (**GH, somatotropin**)
- Lactotrophs: prolactin (**PRL**)
- Melanotrophs: alpha-melanocyte-stimulating hormone (**α-MSH**)





capillaries

**Endocrine gland**

Hormone

| | Diabetes Insipidus | Hypothyroidism | Hyperthyroidism (ca... | Hyperadrenocorticism | Hypoadrenocorticism | Diabetes Mellitus |
|---|---|---|---|---|---|---|
| | Normal | | | SBP 증가, DBP 증가 | Hypovolemia | |

# PUPD 다음다뇨 & Diabetes Insipidus 요붕증

**Polyuria (PU)** : > 50ml/kg/day
**Polydipsia (PD)** : > 100ml/kg/day

많은 양의 희석된 소변 (아무 맛도 나지 않는 소변)을 보는 상태

**ADH**
Target : distal tubule, collecting duct

**Water diuresis (수분이뇨)**
- Primary Polydipsia
- Diabetes insipidus

**Solute (osmotic) diuresis (용질이뇨)**
- Diabetes mellitus
- Mannitol

### Classification

**Primary PD** (secondary polyuria) [rare]
- Psychogenic polydipsia (PP)

**Primary PU** (compensatory polydipsia)
- **CDI (Central diabetes insipidus)**
  - Complete CDI
  - Partial CDI
- **NDI (Nephrogenic diabetes insipidus)**
  - Primary NDI
  - Secondary NDI
- Osmotic diuresis
  - Diabetes mellitus
  - Post-obstructive diuresis
  - Kidney disease
  - Primary renal glycosuria

### Clinical signs

- **PU/PD의 sudden onset**
- noturia, incontinence
- DI의 원인에 의한 증상 (intracranial tumors → CNS signs)

### Diagnostics

### Treatment

# Hypothyroidism

갑상선이 갑상선 호르몬을 제대로 분비하지 못하는 질환

시상하부 → **TRH** → 뇌하수체 전엽 → **TSH** → Thyroid gland (T3, T4, Calcitonin)

### Classification

**Tertiary** hypothyroidism
TRH ↓ TSH ↓ T3/T4 ↓
개와 고양이에서 보고된 바 없음

**Secondary** hypothyroidism
TRH ↑ TSH ↓ T3/T4 ↓

**Primary** hypothyroidism
TRH ↑ TSH ↑ T3/T4 ↓
- Congenital (rare)
- Acquired (90-95%)
  : **Lymphocytic thyroiditis** (common), Idiopathic thyroid necrosis & atrophy

+ **Iatrogenic** hypothyroidism
: Glucocorticoid, methimazole, sulfamethoxazole

### Clinical signs

Skin changes — Hematologic

### Diagnostics

### Treatment

# Hyperthyroidism (cats)

갑상선 호르몬(T4, T3)이 과도하게 생산 및 분비되어 발생하는 상태

VS) Thyrotoxicosis (갑상선 중독증)

= Hypercortisolism, Cushing syndrome

# Hyperadrenocorticism (HAC)

부신 피질에서 cortisol이 과도하게 분비되어 발생하는 질환 / common in dogs

소인
- **Age** | > 6yr
- **Breed** | **Dachshunds, Poodles, Boxers, Boston Terriers**, Terrier breeds, German Shepherd dogs, Beagles, Labrador Retrievers, and Australian Shepherds
- **Sex** | 없음 (PDH), Female (functional adrenal tumor)

### Classification

시상하부 → **CRH** → 뇌하수체 전엽 → **ACTH** → Adrenal cortex → **Cortisol**

- Occult HAC
- Atypical HAC
- Meal/food-induced HAC
- Iatrogenic HAC

**Pituitary-dependant HAC (PDH)** : 80-85%
- Functional ACTH-secreting pituitary adenoma (ACTH-PA) : 85% of PDH
- Pituitary carcinoma
- Hyperplasia of corticotroph cell
- Pituitary ganglion cell tumors

**Functional adrenal tumor-dependent HAC (ATH)** : 15-20%
- Cortex : **Glucocorticoid-secreting adrenocortical tumor**
  - Adrenocortical adenoma & carcinoma
  - Macronodular hyperplasia
- Medulla : **Pheochromocytoma** (갈색세포종)
- Non-functional adrenal tumors

### Clinical signs

Polyuria (water diuresis) — Skin changes

### Diagnostics

### Treatment

= Adrenocortical insufficiency

# Hypadrenocorticism (HOAC)

부신 피질에서 cortisol and/or aldosterone 분비가 감소하는 증후군
(주로 면역매개성 부신피질 조직 파괴로 인함)

소인
- **Age** | young to middle - (dogs) 3-4년령, (cats) 6년령
- **Breed** | **Poodles**를 비롯한 순종에서 다발 (West Highland white terriers, Great Danes, Portuguese Water Spaniels, Beared Collies..)
- **Sex** | **Female** in dogs

### Classification

시상하부 → **CRH** → 뇌하수체 전엽 → **ACTH** → Adrenal cortex → Cortisol, Aldosterone

**Tertiary hypoadrenocorticism**
CRH ↓ ACTH ↓ Cortisol ↓ Aldosterone 정상
개에서 보고된 바 없음

**Secondary hypoadrenocorticism**
CRH ↑ ACTH ↓ Cortisol ↓ Aldosterone 정상 (RAAS system의 조절을 받기 때문)
- Pituitary lesion (선천적 결손, 염증, 종양 등)
- Iatrogenic (스테로이드 투약 중지) : 대부분 이 경우

**Primary hypoadrenocorticism (Addison's disease)** : 95-97%
CRH ↑ ACTH ↑ Cortisol ↓ Aldosterone ↓
- **Typical/Classic** Primary hypoadrenocorticism
- Atypical primary hypoadrenocorticism

### Clinical signs

Common features — Others — Addison Crisis (Acute adrenal insufficiency)

### Diagnostics

### Treatment

# Diabetes Mellitus (DM)

단 소변이 다량으로 나오는 상태
인슐린이 제대로 생산 또는 작용하지 못해 발생하는 혈당조절 장애 (common in dogs & cats)

소인
- **Age** | 나이가 많을수록 발병률 증가 : (dogs) 7-12yr, (cats) 10-13yr
- **Breed** | (cats) **Burmese**, Russian Blue, Norwegian Forest, Abyssinian cats
- **Sex** | (dogs) Female & Neutered Male, (cats) Neutered Male

**Pancreas**
- Exocrine pancreas — Acinar cells, Ductal cells
- Endocrine pancreas
  - α-cells — glucagon
  - β-cells — insulin
  - δ-cells — somatostatin
  - PP or F cells — pancreatic polypeptide

### Classification

| Type 1 DM | Type 2 DM |
|---|---|
| common in dogs rare in cats | common in cats rare in dogs |
| rapid onset | gradual onset |
| normal or underweight | overweight (~80%) |
| ketosis common | ketosis rare |
| familial factor ↓ | strongly hereditary |
| insulin therapy ↑ | diet and exercise ↑ |

**Type 1 DM** (IDDM = insulin dependent DM)

**Type 2 DM** (NIDDM = non- insulin dependent DM)

**Other specific types of DM**
- Drug-induced DM
- Genetic defects of insulin
- Endocrinopathies antagonizing insulin
- Diseases of the exocrine pancreas
- Gestational DM (임신성 당뇨)

당뇨의 급성 합병증

**DKA (Diabetic Ketoacidosis)** — **HHS (Hyperglycemic Hyperosmolar Syndrome)**

### Clinical signs

### Diagnostics

### Treatment

Insulin therapy — Oral hypoglycemic drugs — Diet — Exercise