

*If the patient is severely  
hyponatraemic or  
hypernatraemic,*

*you can be sure there is a doctor  
involved.*

# MANTRAS

# MANTRAS

Na content  $\neq$  [Na]

# MANTRAS

Na content  $\neq$  [Na]

Na content  $\rightarrow$  ECF size

# MANTRAS

Na content  $\neq$  [Na]

Na content  $\rightarrow$  ECF size

Water content  $\rightarrow$  ICF size

# MANTRAS

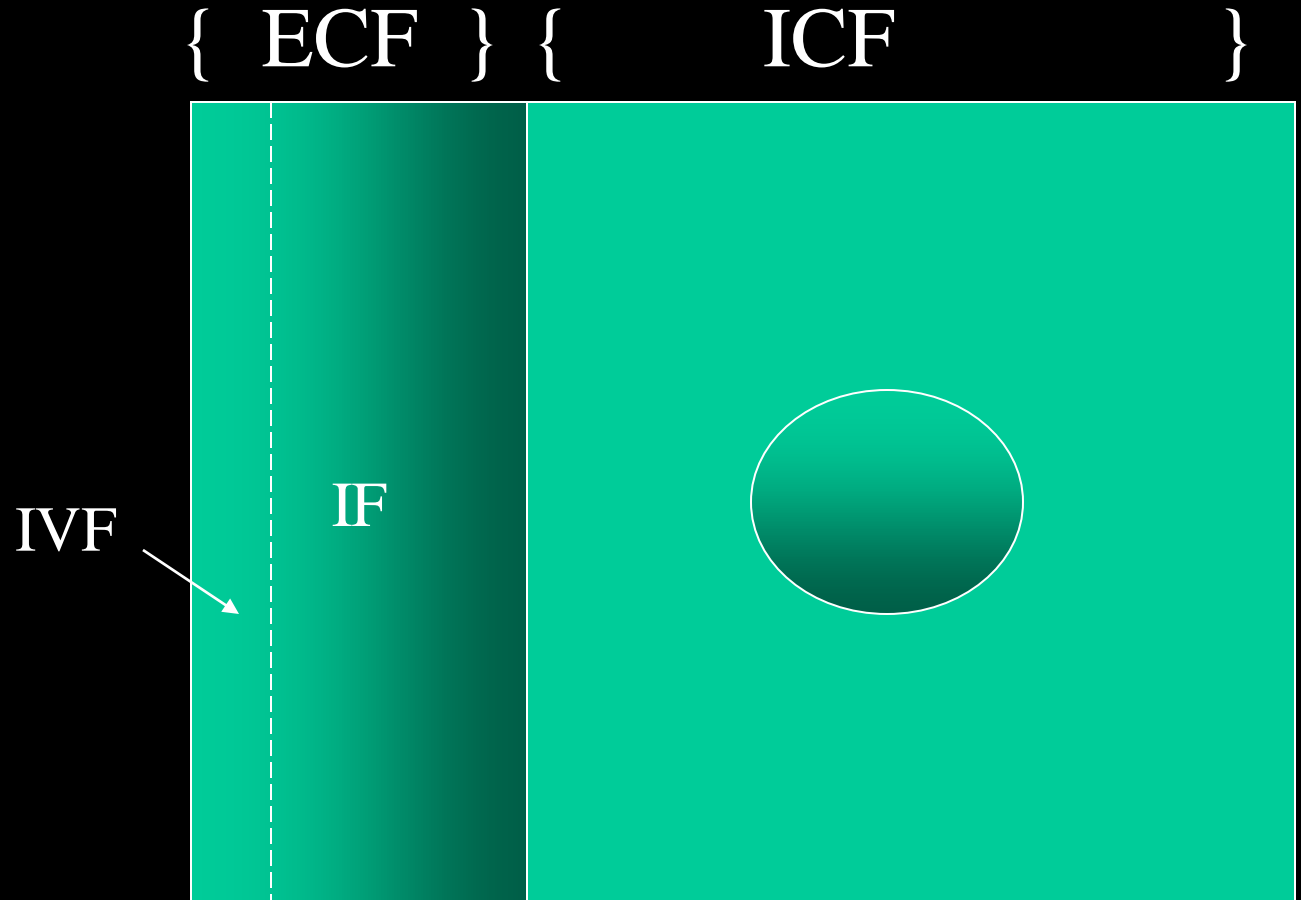
Na content  $\neq$  [Na]

Na content  $\rightarrow$  ECF size

Water content  $\rightarrow$  ICF size

Water content  $\propto$   $1/[\text{Na}]$

Normal

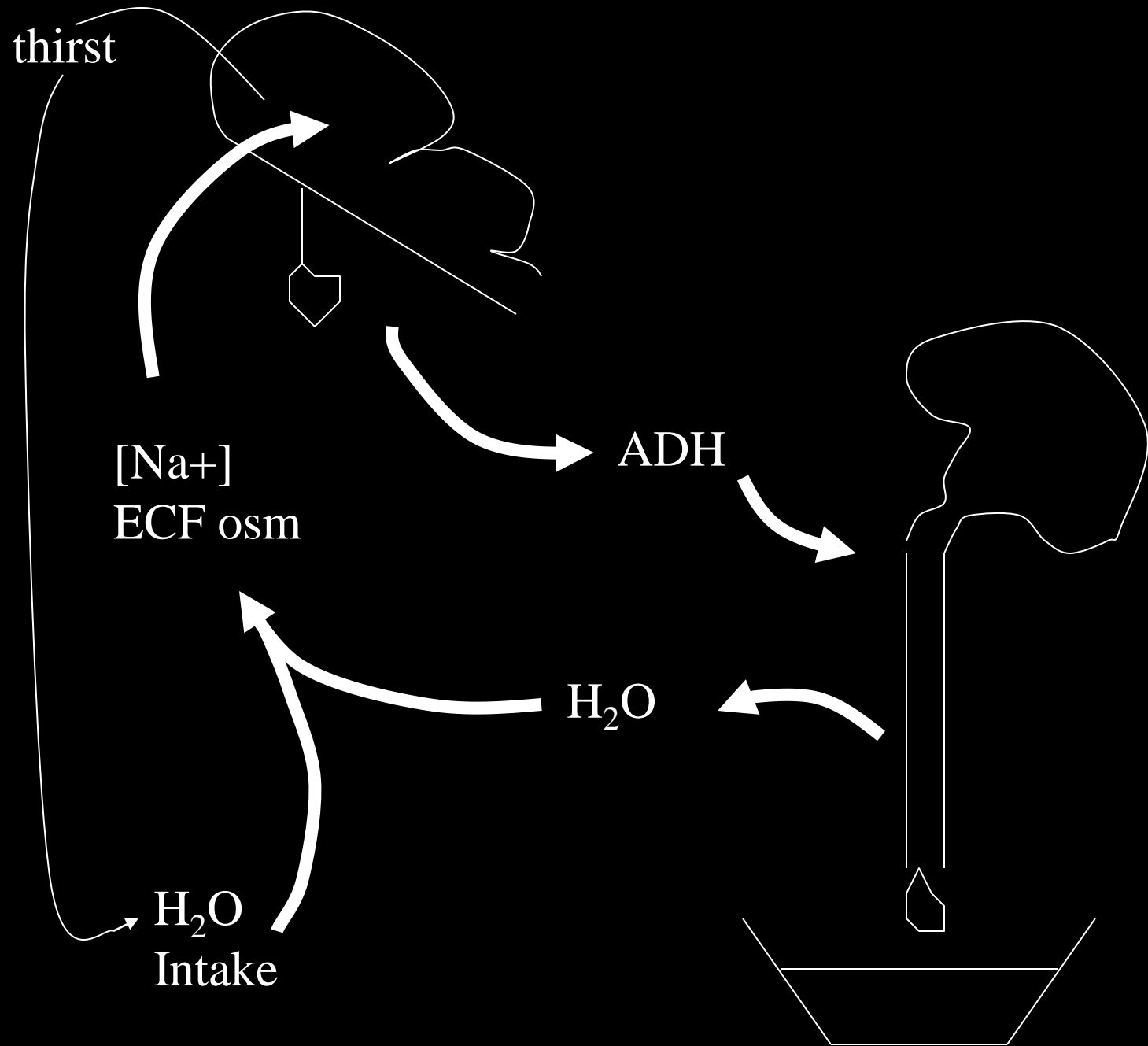


# WATER PROBLEMS

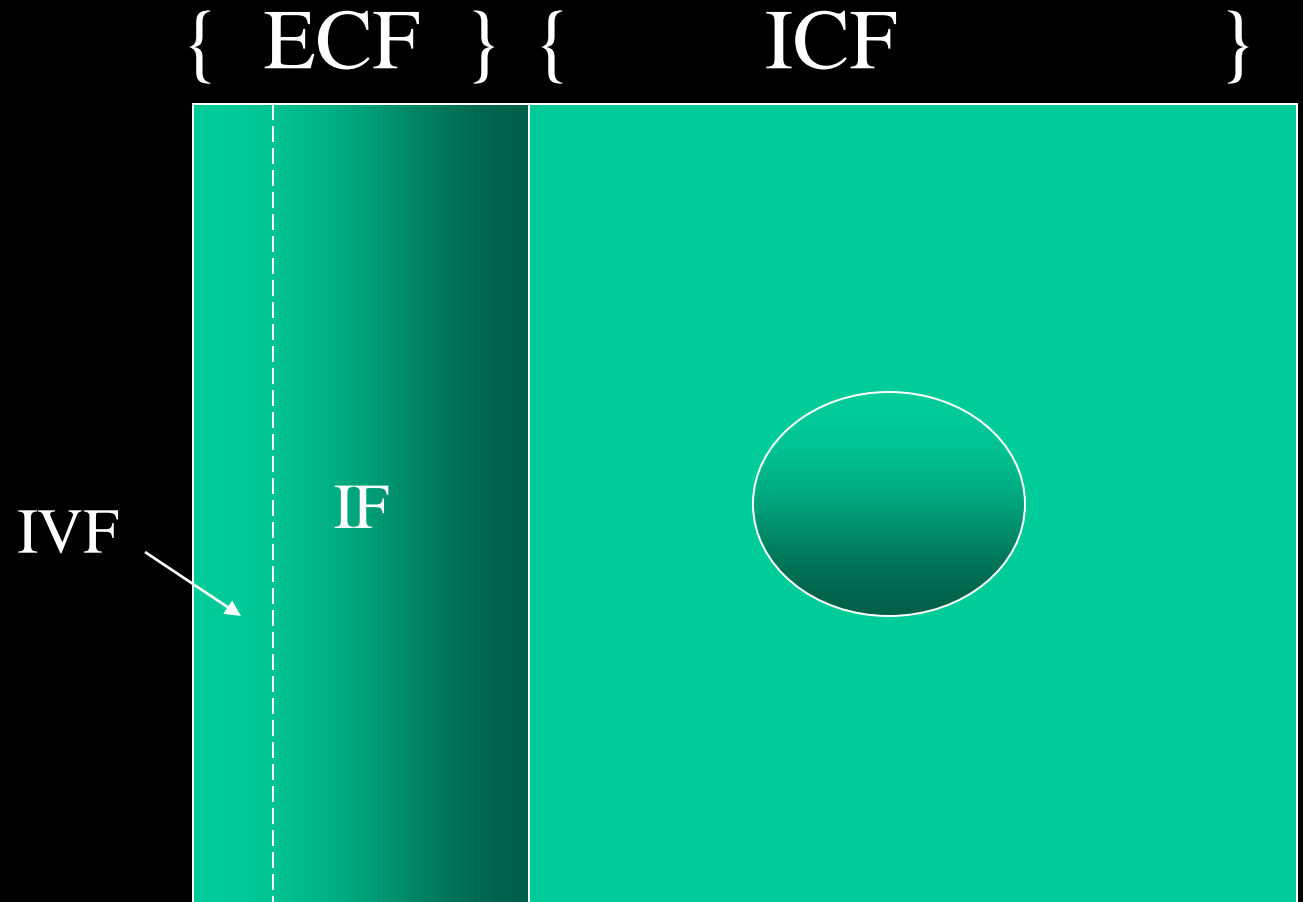


# WATER PROBLEMS

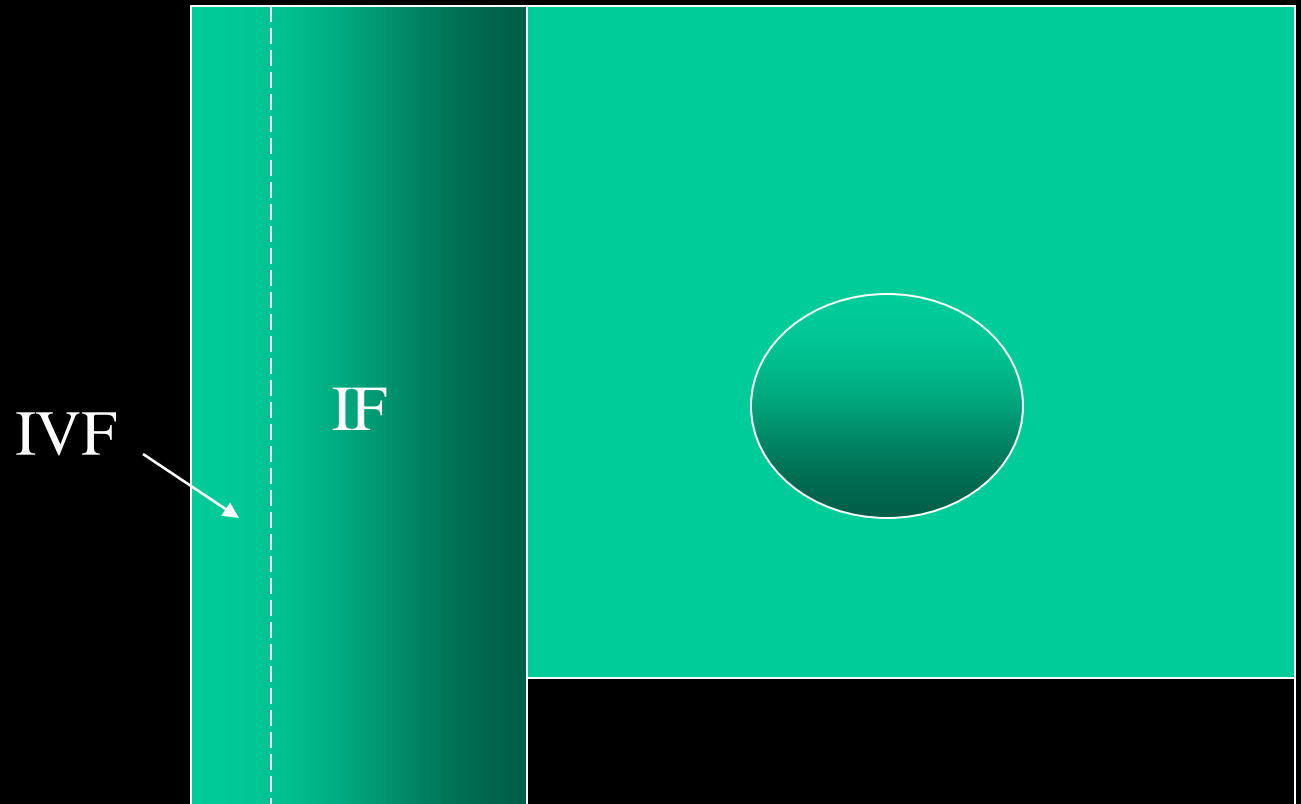
- Water deficit



Normal



{ ECF } { ICF }



How to recognize?

# How to recognize?

- Hyponatraemia

# How to recognize?

- Hyponatraemia
- (thirst)

# How to recognize?

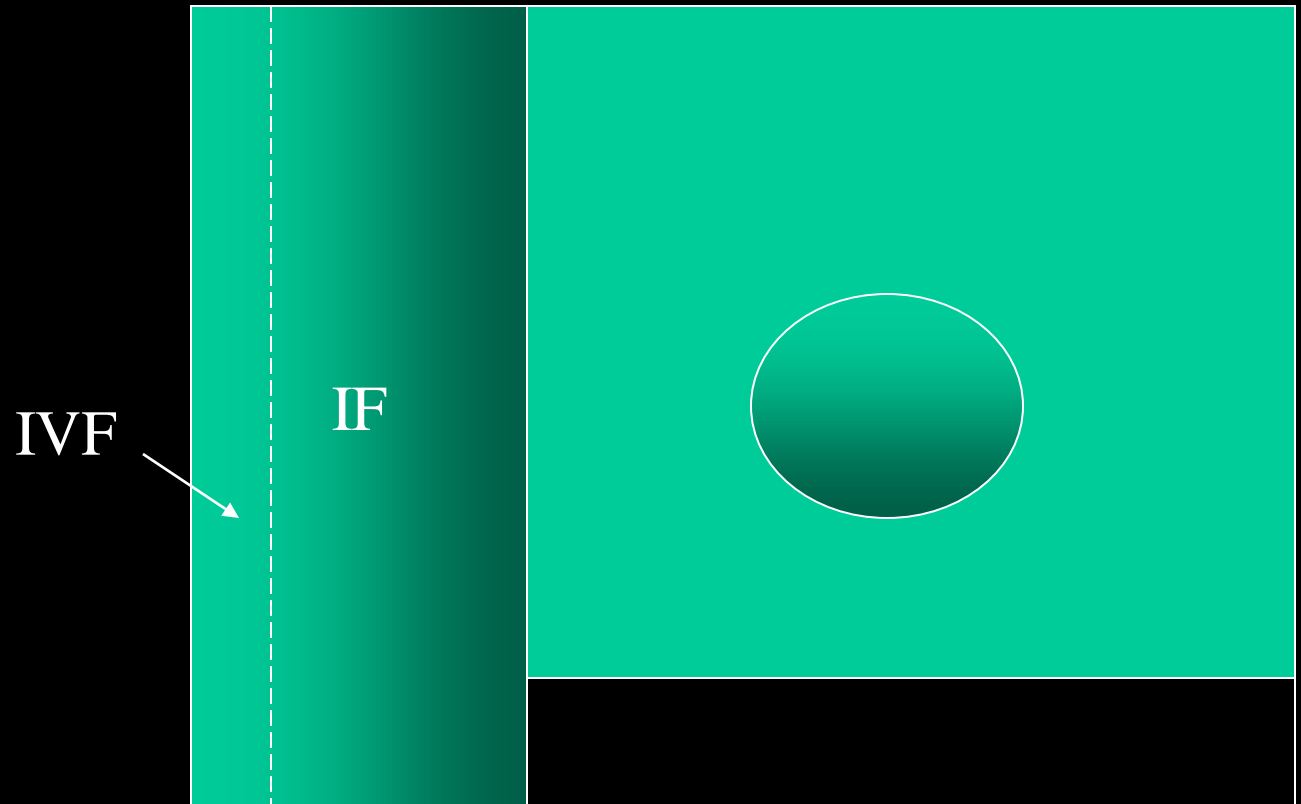
- Hyponatraemia
- (thirst)
- Shock?



# How to recognize?

- Hyponatraemia
- (thirst)
- Shock? *No*

{ ECF } { ICF }



How to treat?

# How to treat?

- Give water

# How to treat?

- Give water
  - NG

# How to treat?

- Give water
  - NG
  - IV

# How to treat?

- Give water
  - NG
  - IV      Glucose 5%

# How to treat?

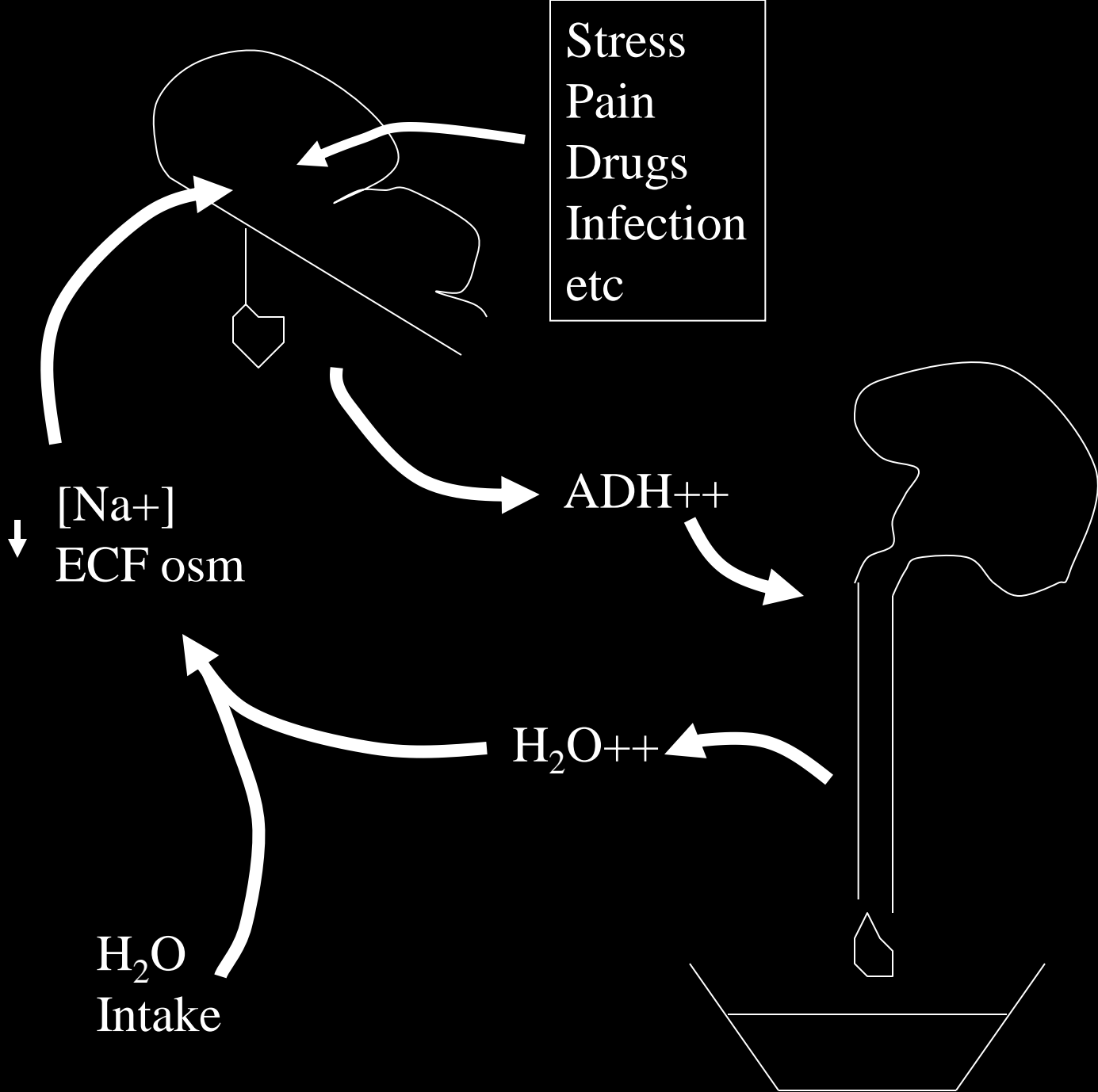
- Give water
  - NG
  - IV      Glucose 5%
  
- Give Na?



# How to treat?

- Give water
  - NG
  - IV      Glucose 5%
- Give Na?      *No*

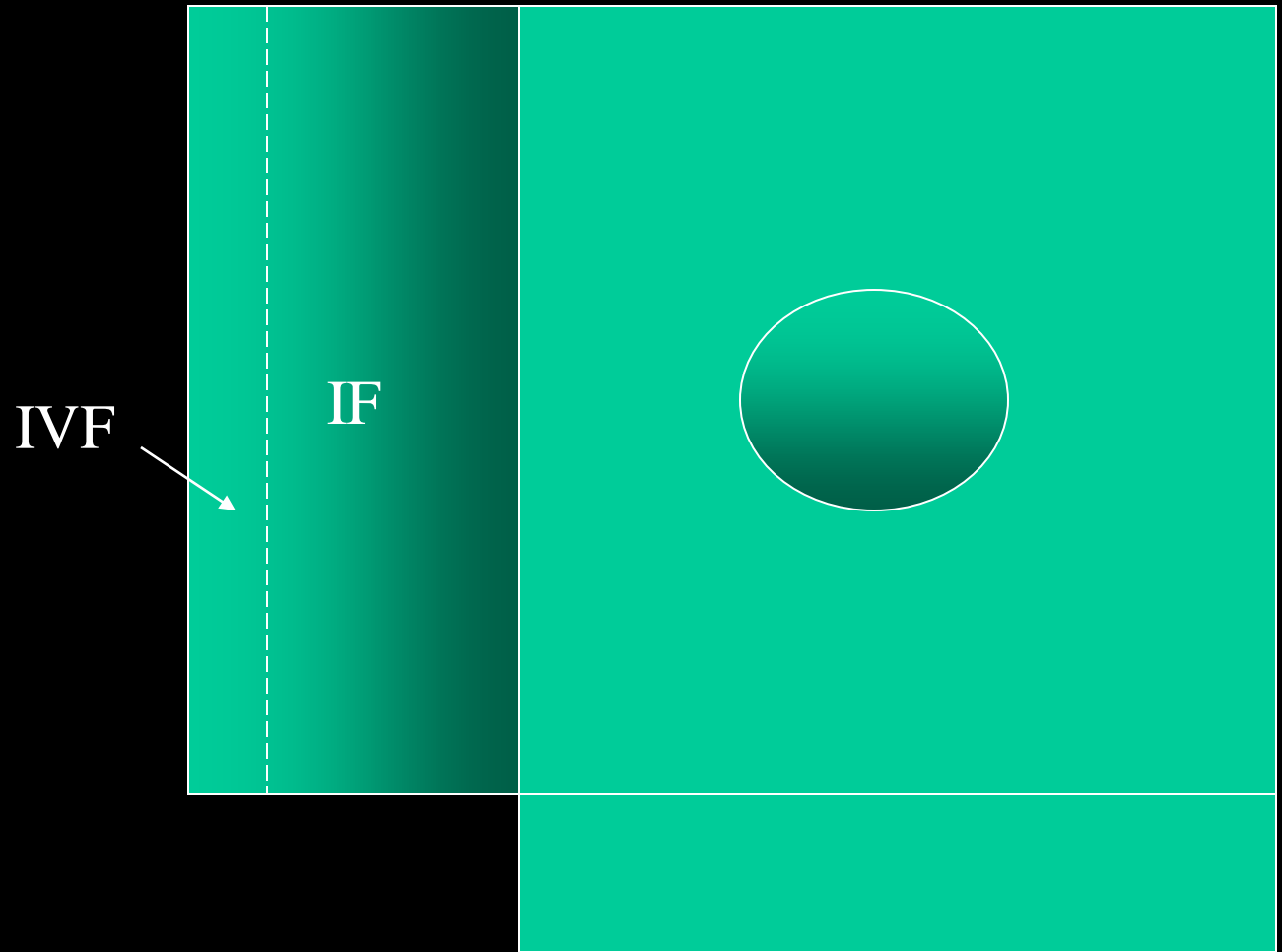
- Water excess



- Na 134 mmol/L

- Na 134 mmol/L (135-145)

{ ECF } { ICF }



How to recognize?

# How to recognize?

- Hyponatraemia



# How to recognize?

- Hyponatraemia
- Clinical upset?

# How to recognize?

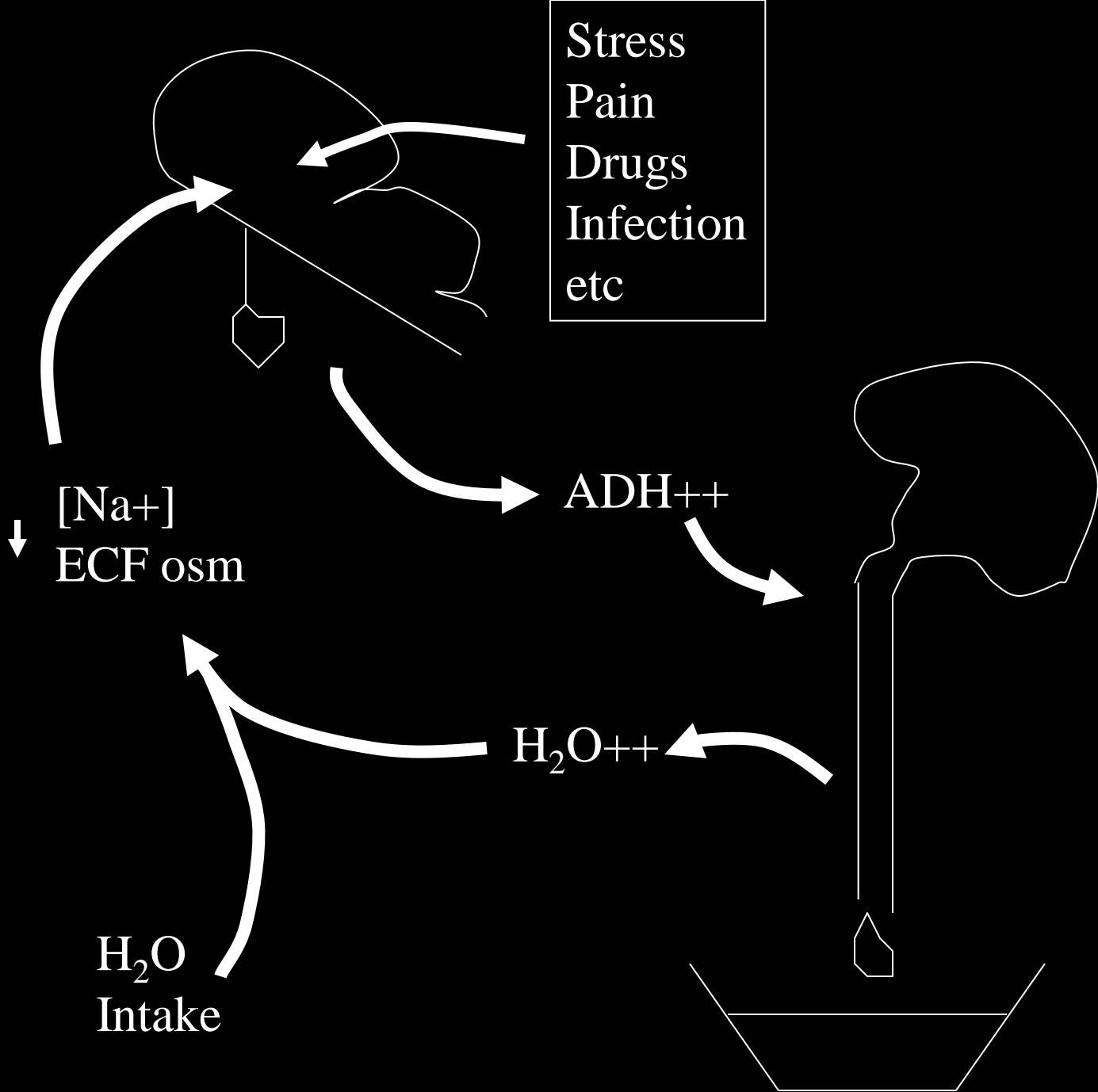
- Hyponatraemia
- Clinical upset?      CNS

# How to recognize?

- Hyponatraemia
- Clinical upset?      CNS
- Urine output?

# How to recognize?

- Hyponatraemia
- Clinical upset?            CNS
- Urine output?            lowish



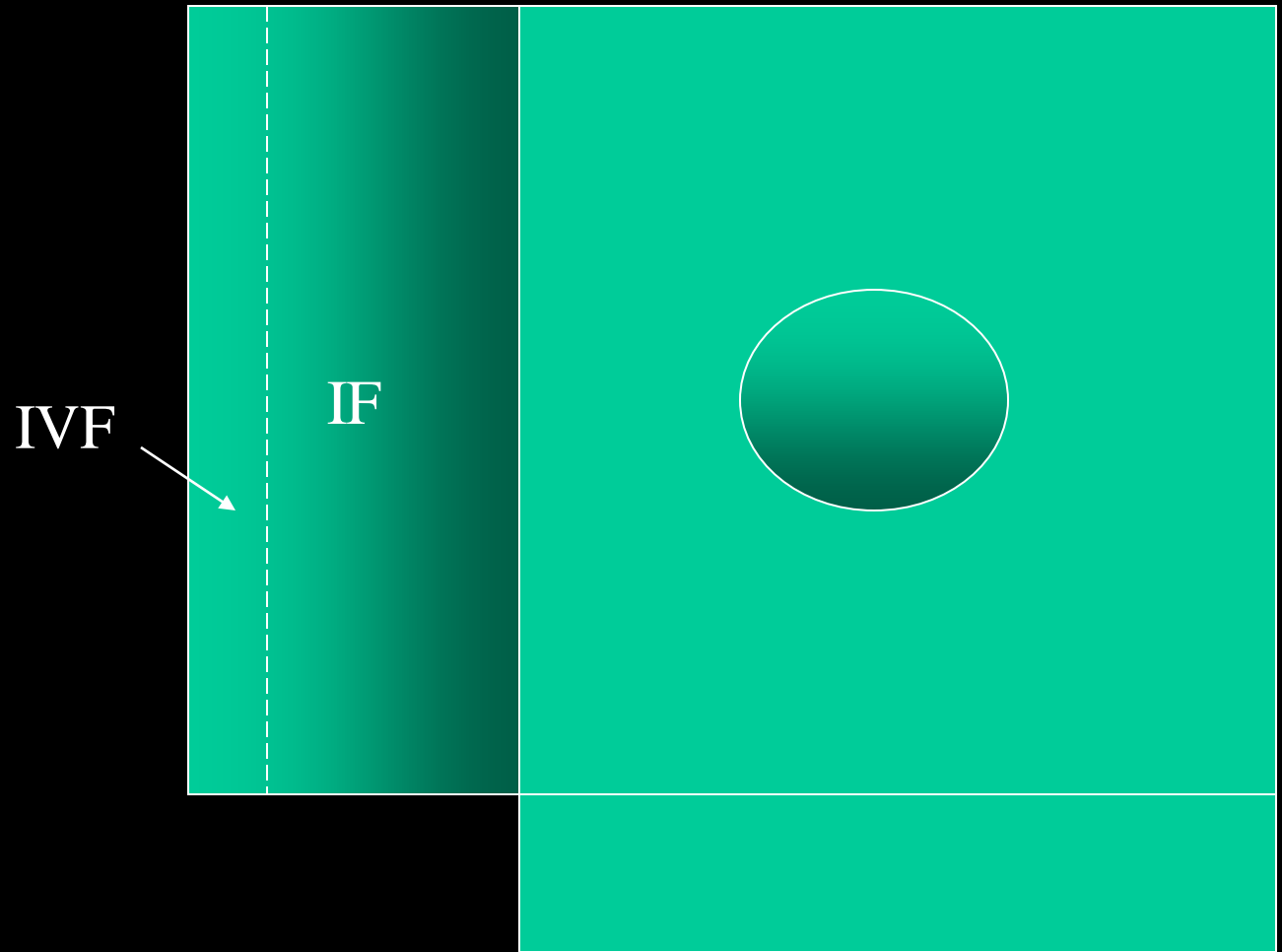
# How to recognize?

- Hyponatraemia
- Clinical upset?            CNS
- Urine output?            lowish
- Oedema?

# How to recognize?

- Hyponatraemia
- Clinical upset? CNS
- Urine output? lowish
- Oedema? *No*

{ ECF } { ICF }





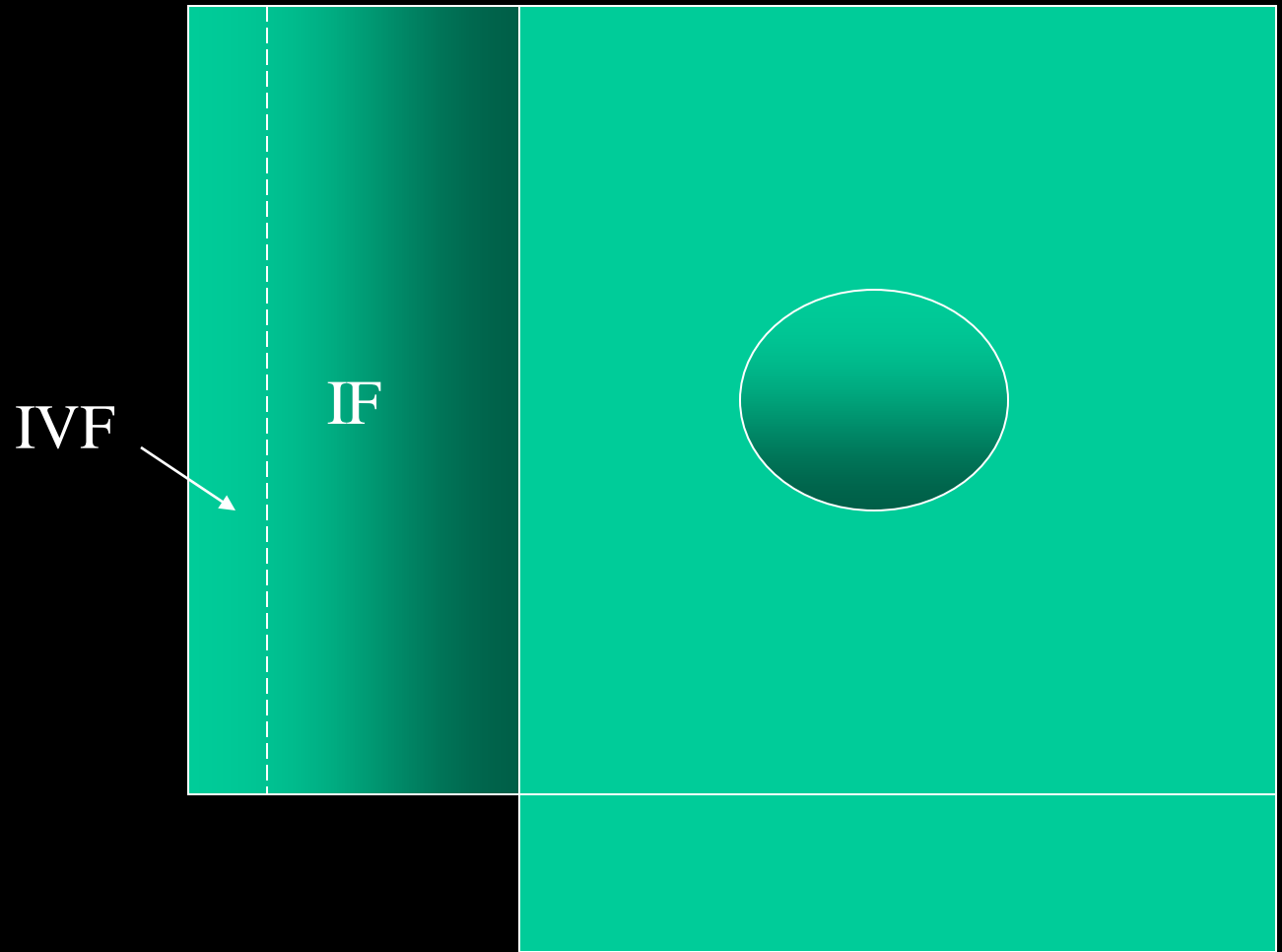
# How to recognize?

- Hyponatraemia
- Clinical upset? CNS
- Urine output? lowish
- Oedema? *No*
- Shock?

# How to recognize?

- Hyponatraemia
- Clinical upset? CNS
- Urine output? lowish
- Oedema? *No*
- Shock? *No*

{ ECF } { ICF }



# How to recognize?

- Hyponatraemia
- Clinical upset?            CNS
- Urine output?                lowish
- Oedema?                        *No*
- Shock?                         *No*
- Renal function?

# How to recognize?

- Hyponatraemia
- Clinical upset? CNS
- Urine output? lowish
- Oedema? *No*
- Shock? *No*
- Renal function? normal

How to treat?

# How to treat?

- *When in a hole....*

# How to treat?

- *When in a hole....stop digging*



# How to treat?

- Stop giving water

# How to treat?

- ...*behaving as if in the desert*....

# How to treat?

- *....behaving as if in the desert....*
- *.....put him in the desert!*

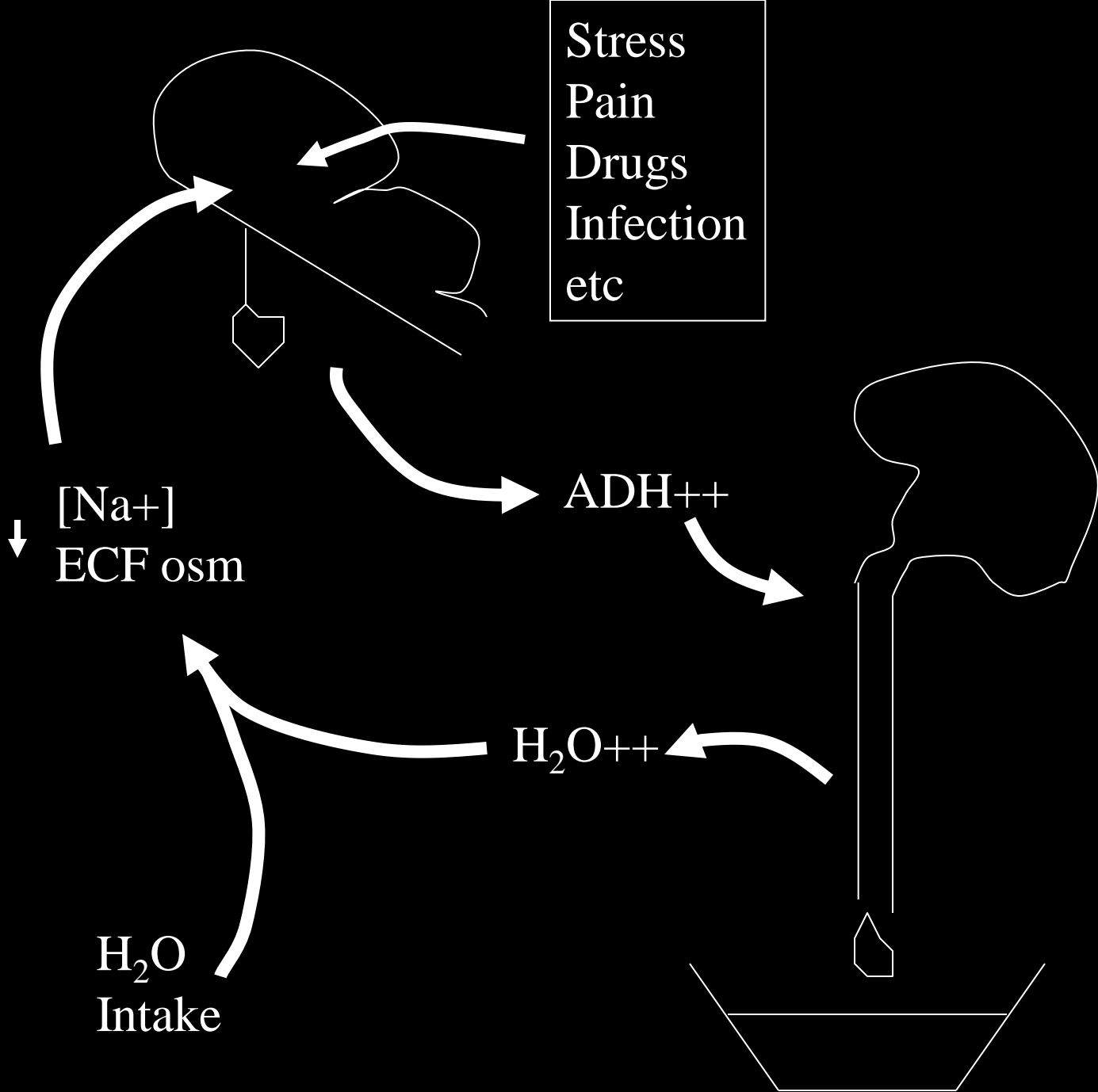
- “*maintenance*”

# How to treat?

- Stop giving water

# How to treat?

- Stop giving water
- Cruel to patient? *No*

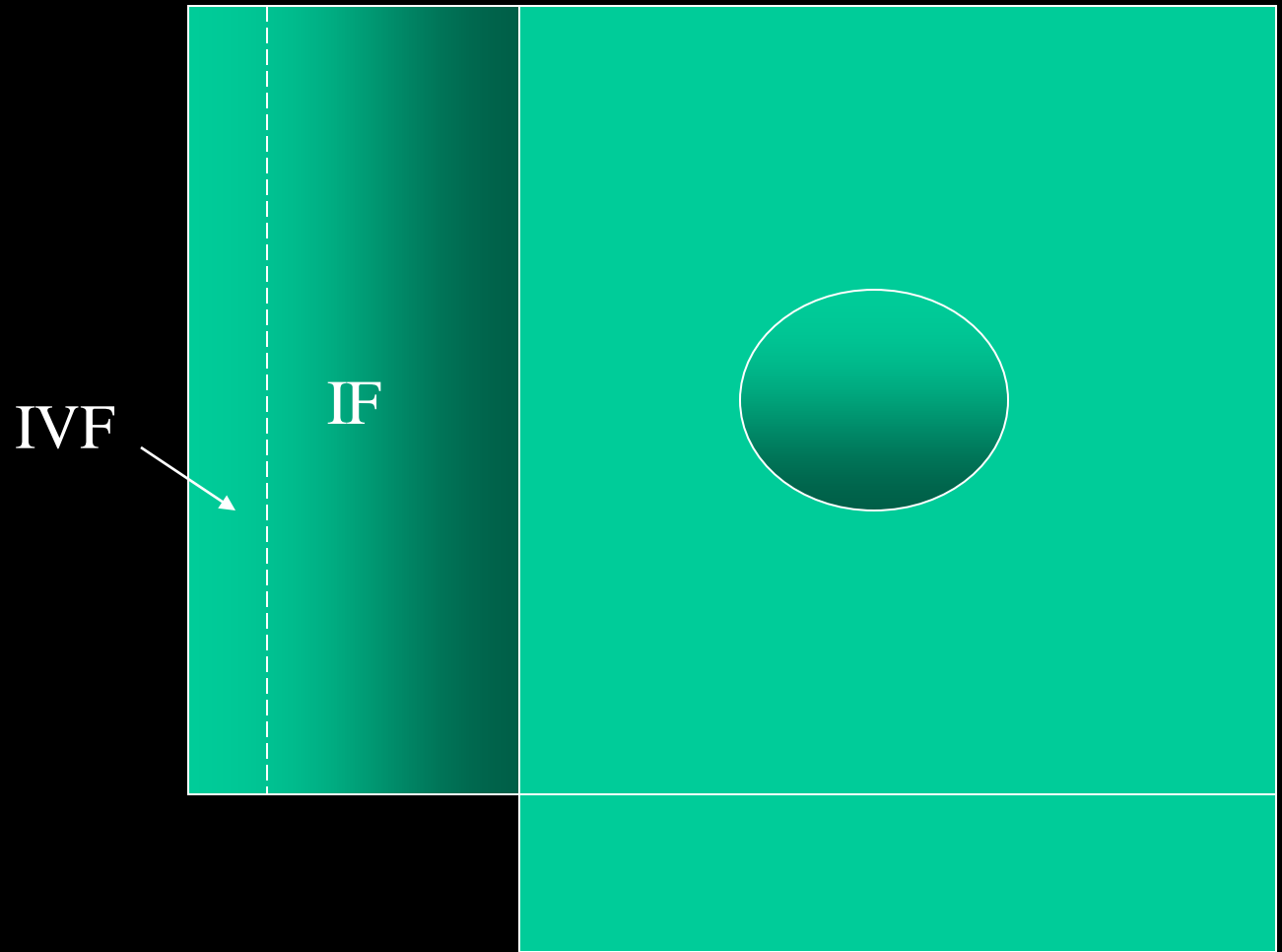


# Water excess

- Serious?



{ ECF } { ICF }



# Water excess

- Serious?
  - Brain swelling





# Water excess

- Serious?
  - Brain swelling
  - Central pontine myelinolysis      CPM

# How to treat?

- Stop giving water
- Cruel to patient? *No*
- Give Na?

# How to treat?

- Stop giving water
- Cruel to patient? *No*
- Give Na? *No*

Why not give Na?



# Why not give Na?

- No Na deficit

# Why not give Na?

- No Na deficit      *wrong treatment*

# Why not give Na?

- No Na deficit                    *wrong treatment*
- Quickly



# Why not give Na?

- No Na deficit                    *wrong treatment*
- Quickly                            *rapid rise in [Na]*
- Perpetuate problem

# Why not give Na?

- No Na deficit *wrong treatment*
- Quickly *rapid rise in [Na]*
- Perpetuate problem *giving water*

# Why not give Na?

- No Na deficit *wrong treatment*
- Quickly *rapid rise in [Na]*
- Perpetuate problem *giving water*
- Cause oedema

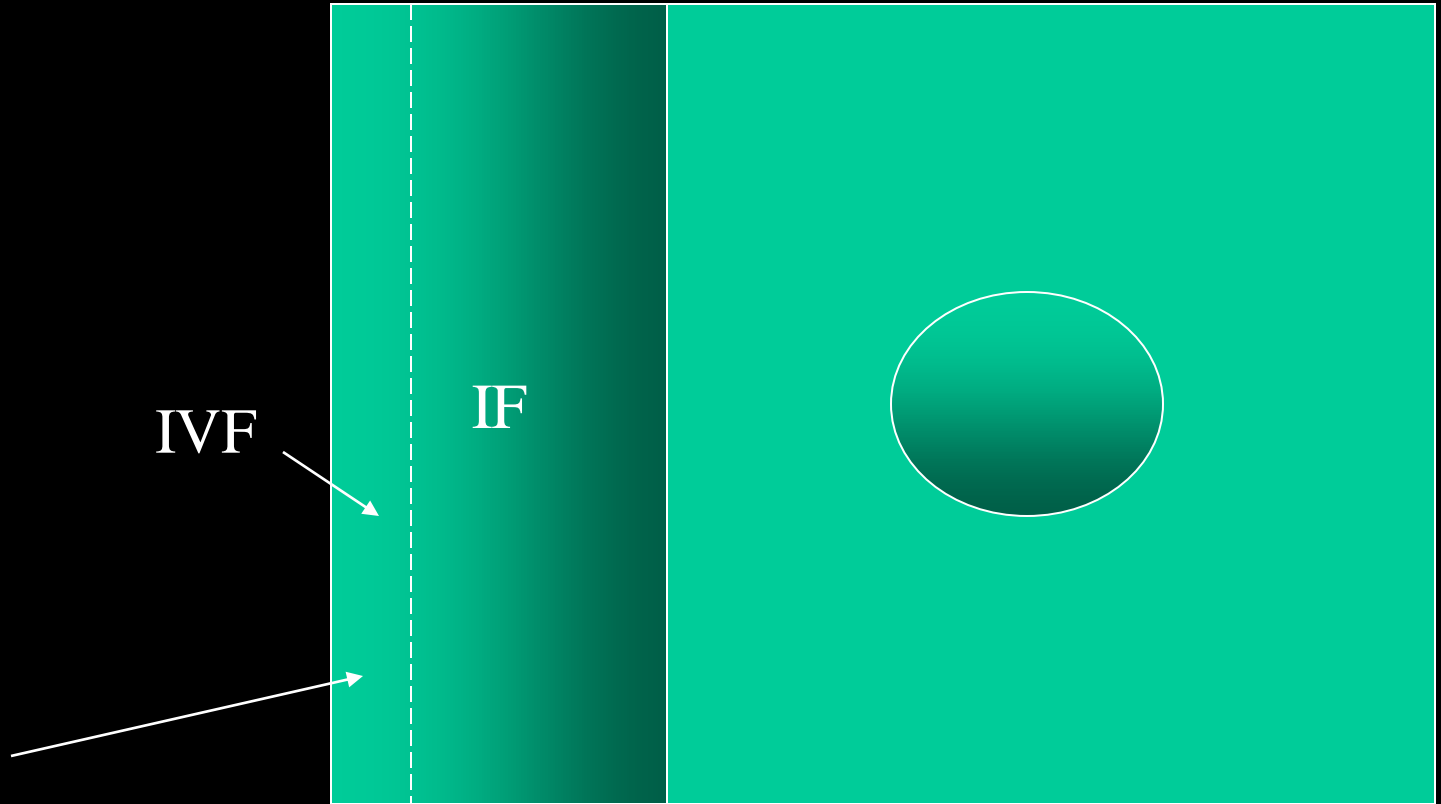
Water content  $\propto$  ICF size  $\propto$   $1/[\text{Na}^+]$



Na<sup>+</sup> Excess

Normal

{ ECF } { ICF }

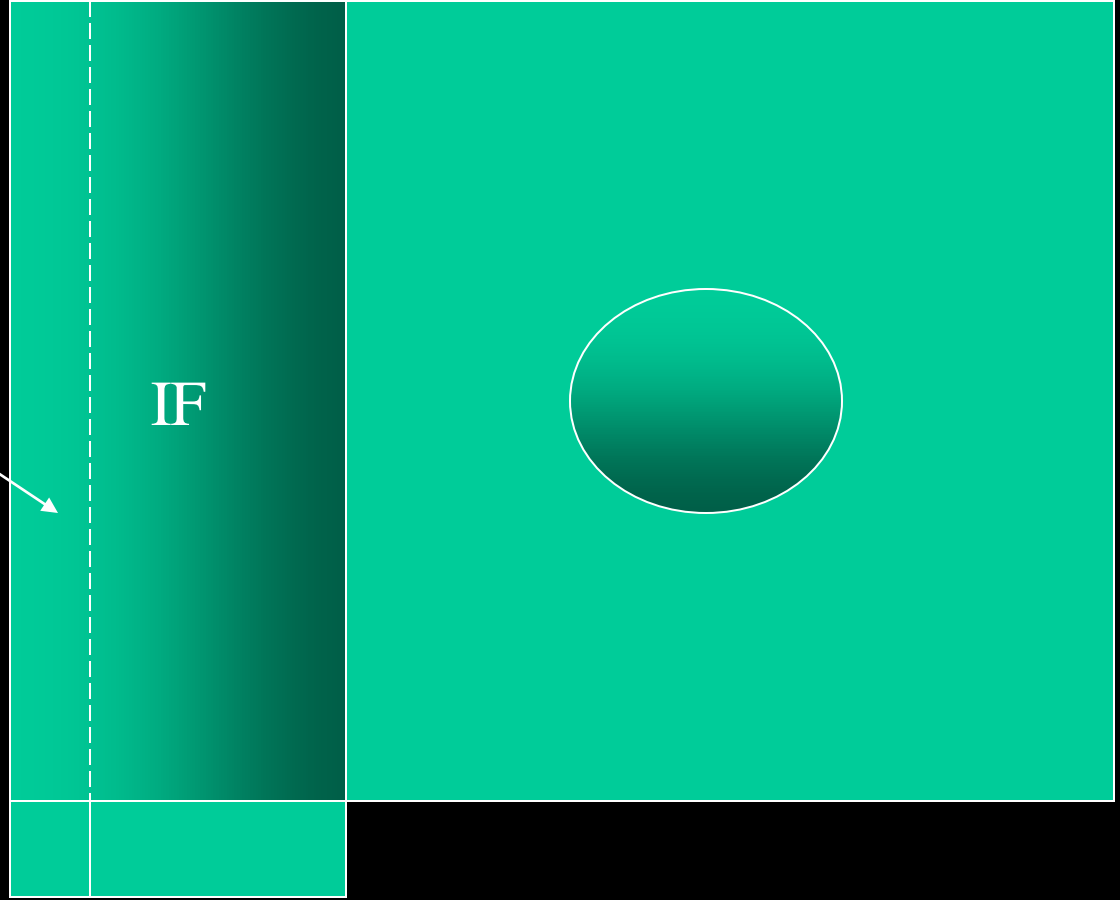
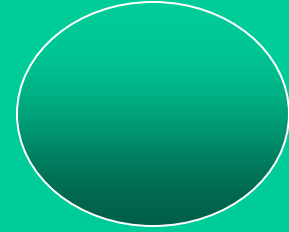


{ ECF } { ICF }

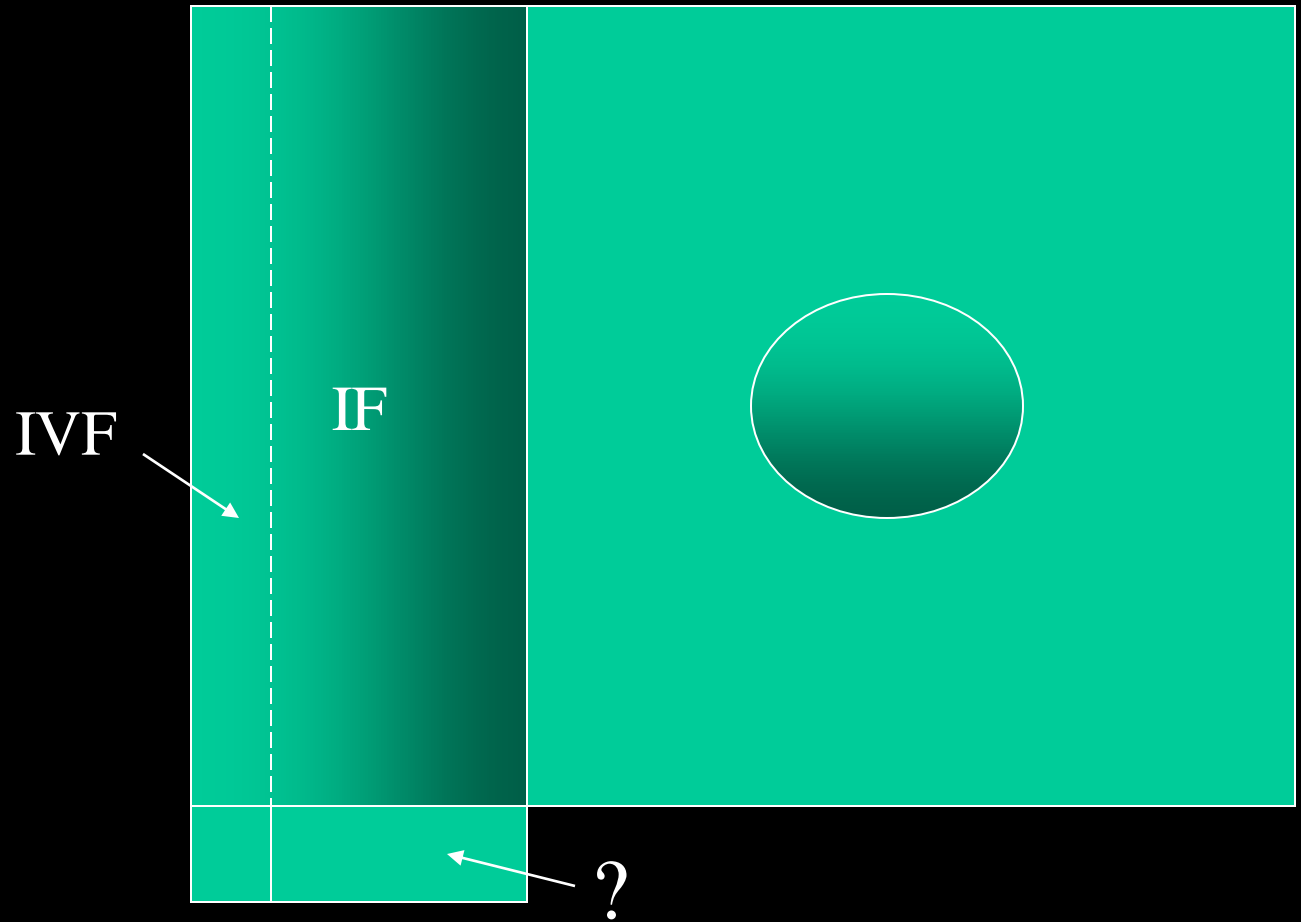
IVF

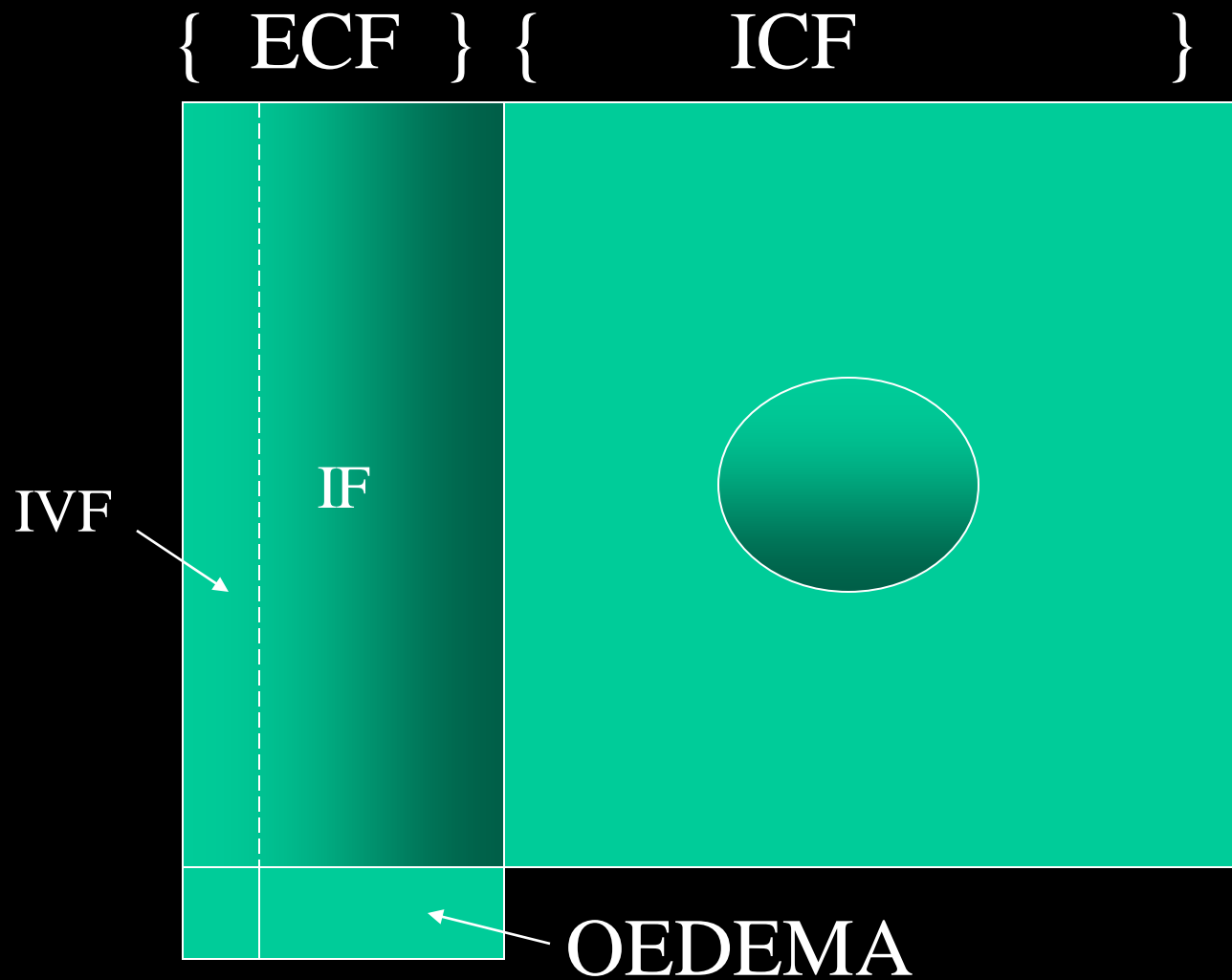


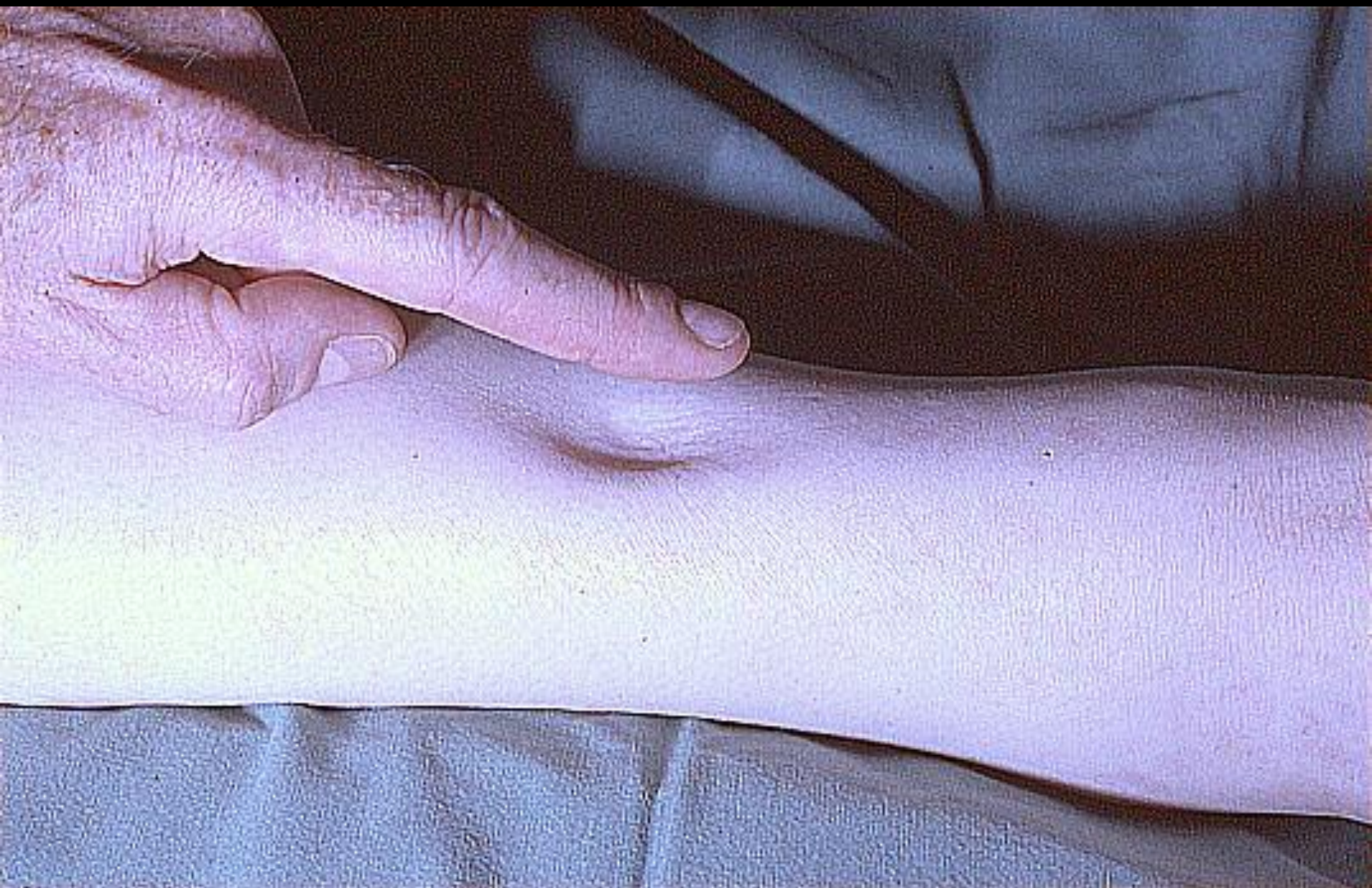
IF

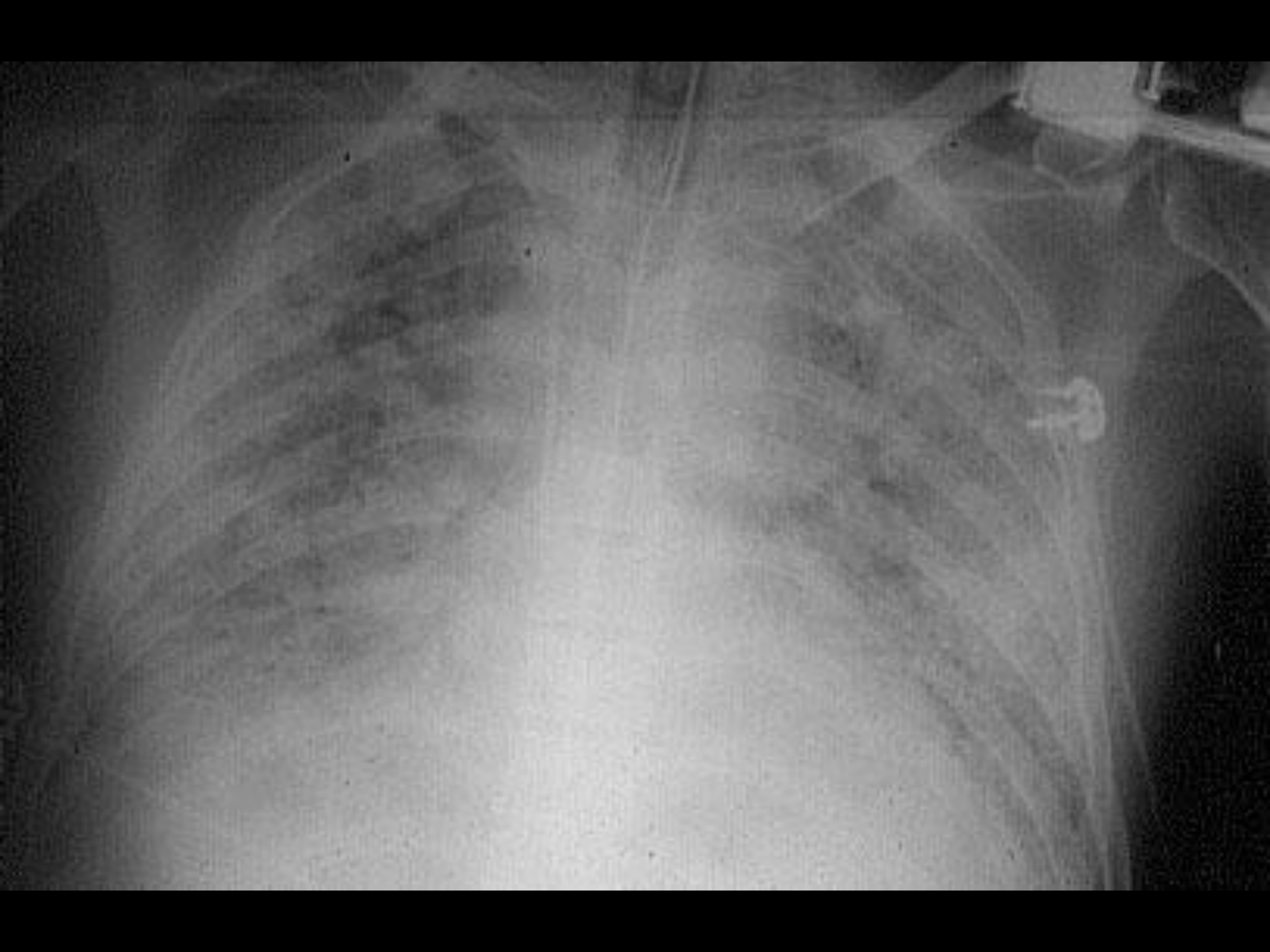


{ ECF } { ICF }









How Na excess?



# How Na excess?

- Doctors

# How Na excess?

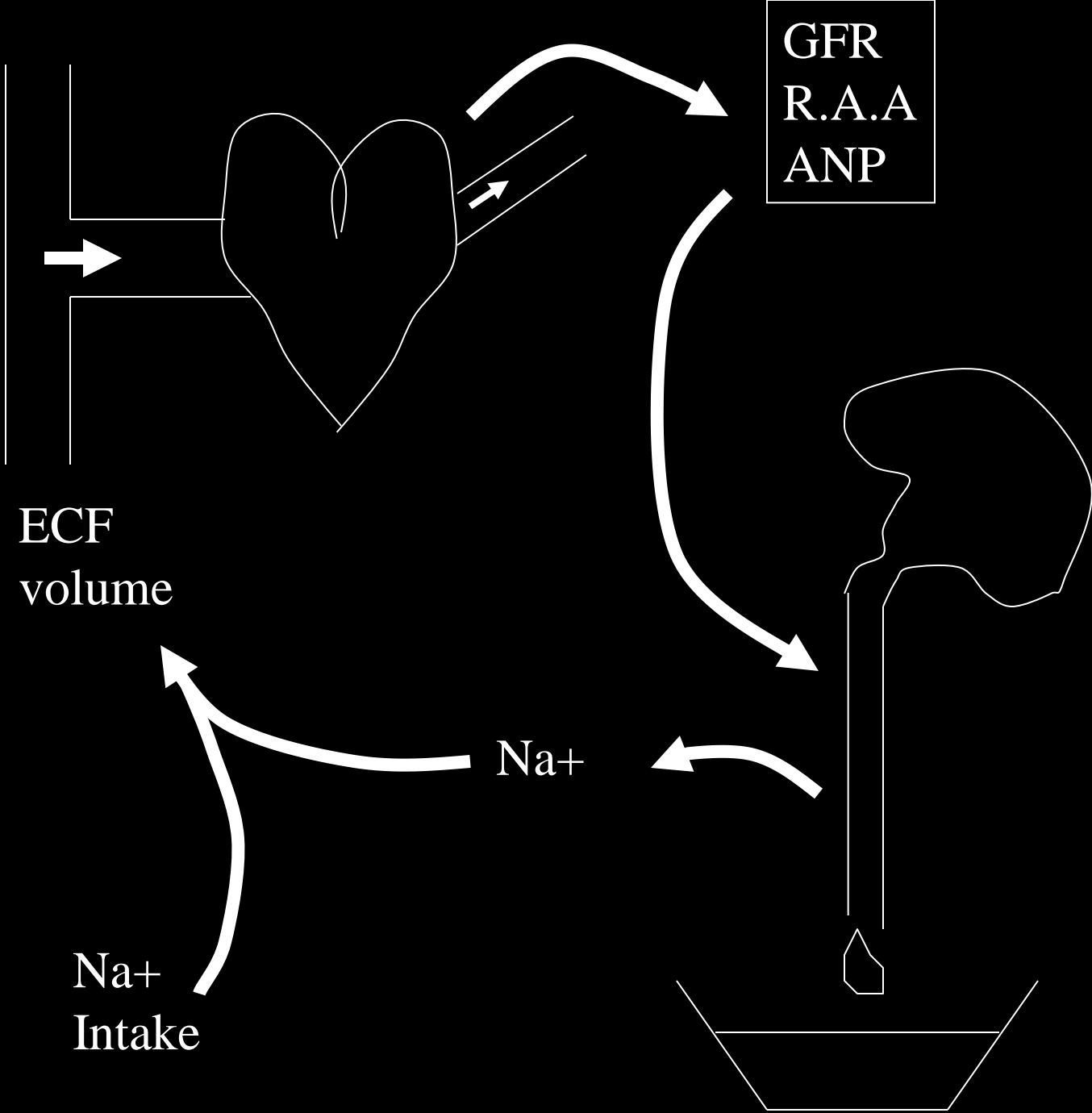
- Doctors
  - Consciously

# How Na excess?

- Doctors
  - Consciously
  - unconsciously

# How Na excess?

- Doctors
  - Consciously
  - unconsciously
- Why not excrete excess Na?



# How Na excess?

- Doctors
  - Consciously
  - unconsciously
- Why not excrete excess Na?
  - “stress”

# How Na excess?

- Doctors
  - Consciously
  - unconsciously
- Why not excrete excess Na?
  - “stress”      Na retention

How to recognize?



# How to recognize?

- Oedema

# How to recognize?

- Oedema
- Shock?

# How to recognize?

- Oedema
- Shock?

*No*

# How to recognize?

- Oedema
- Shock? *No*
- [Na]?

# How to recognize?

- Oedema
- Shock? *No*
- [Na]? *No change*

# How to recognize?

- Oedema
- Shock? *No*
- [Na]? *No change*
- Renal function?

# How to recognize?

- Oedema
- Shock? *No*
- [Na]? *No change*
- Renal function?
  - Dysfunction → Na excess

# How to recognize?

- Oedema
- Shock? *No*
- [Na]? *No change*
- Renal function?
  - Dysfunction → Na excess
  - Na excess ↗ dysfunction



How to treat?

# How to treat?

- Stop giving Na

# How to treat?

- Stop giving Na
- Actively remove Na

- a Mannitol
- b Glucose
- c D-methyltetracycline
- d Urea
- e Frusemide
- f All of the above

*“Diuretics”*

*Natriureticum*

*Saliuretique*

- Water content

- Increased

- Normal

- Decreased

- Na content

- Increased

- Normal

- Decreased

Na deficit:



Na deficit:  
*arising how ?*

Na deficit:  
*arising how ?*

- Na loss

# Na deficit: *arising how ?*

- Na loss
  - GI

# Na deficit: *arising how ?*

- Na loss
  - GI
  - Renal

# Na deficit: *arising how ?*

- Na loss
  - GI
  - Renal
  - Drain, wound

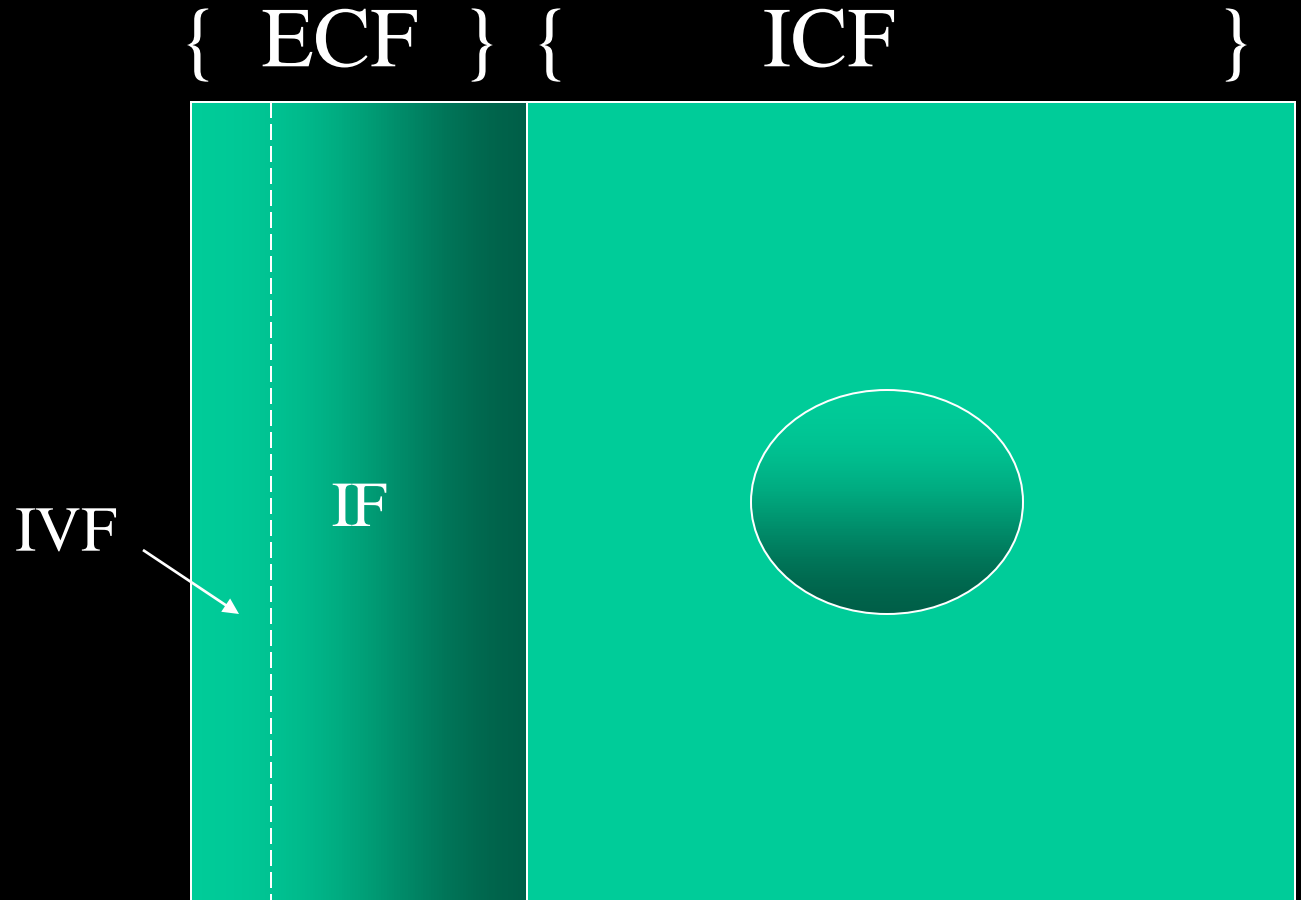
# Na deficit: *arising how ?*

- Na loss
  - GI
  - Renal
  - Drain, wound
  - Internal

# Na deficit: *arising how ?*

- Na loss
  - GI
  - Renal
  - Drain, wound
  - Internal      *“third space”*

Normal

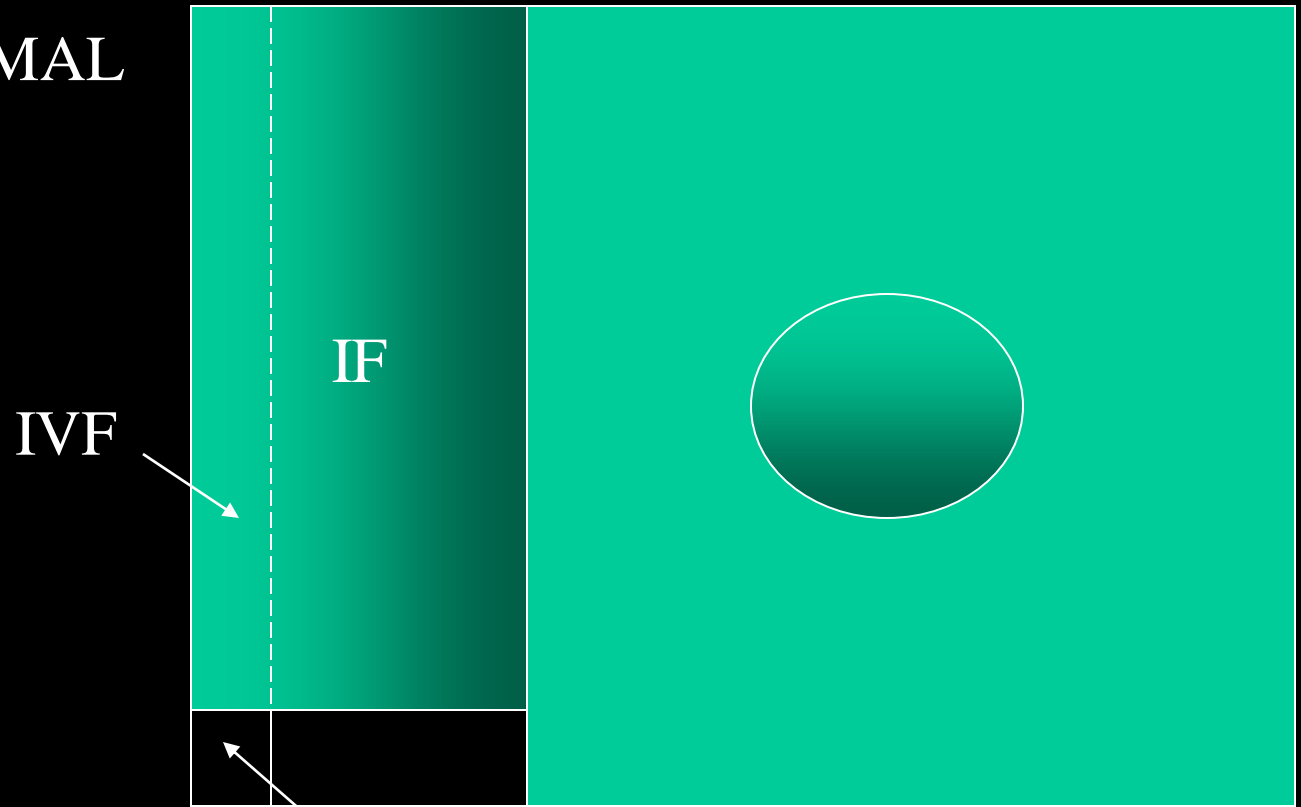




NaCl DEFICIT

{ ECF } { ICF }

[Na+] NORMAL

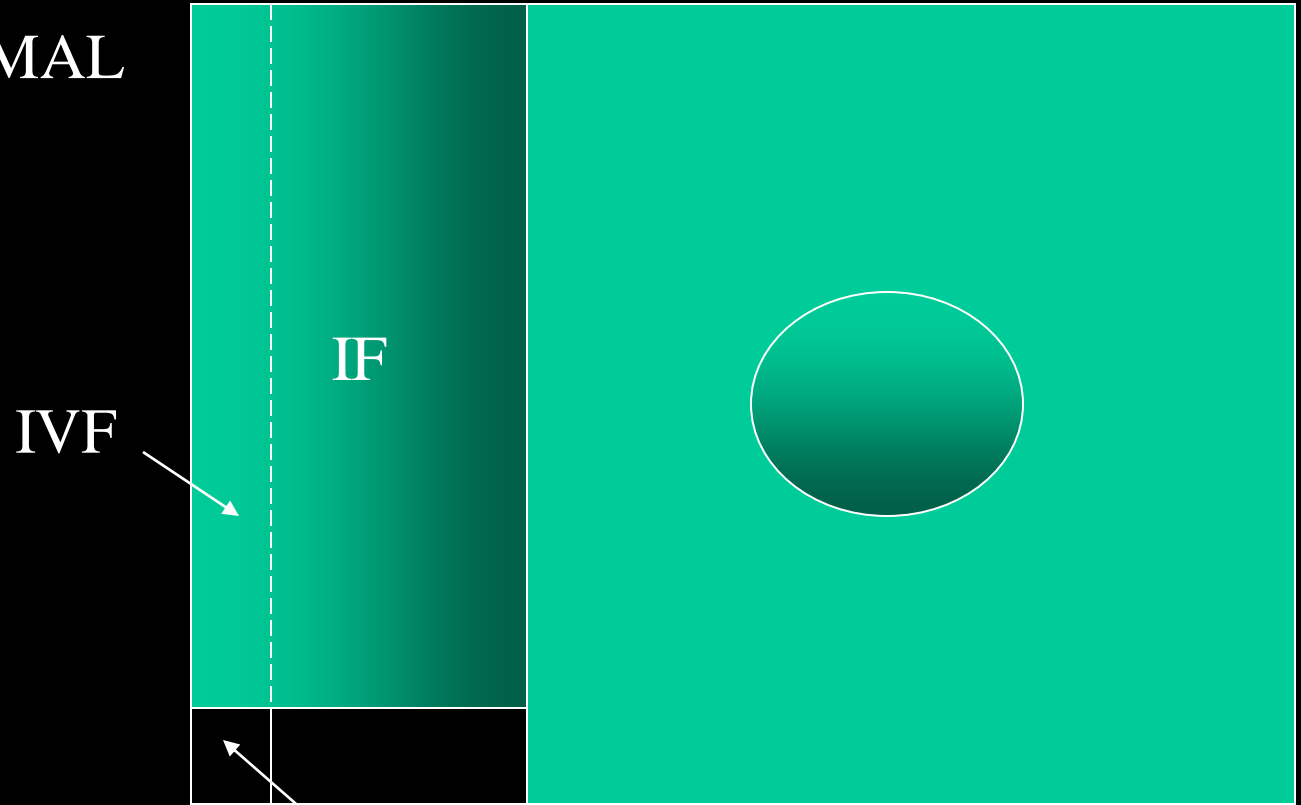


?

NaCl DEFICIT

{ ECF } { ICF }

[Na+] NORMAL



IVF

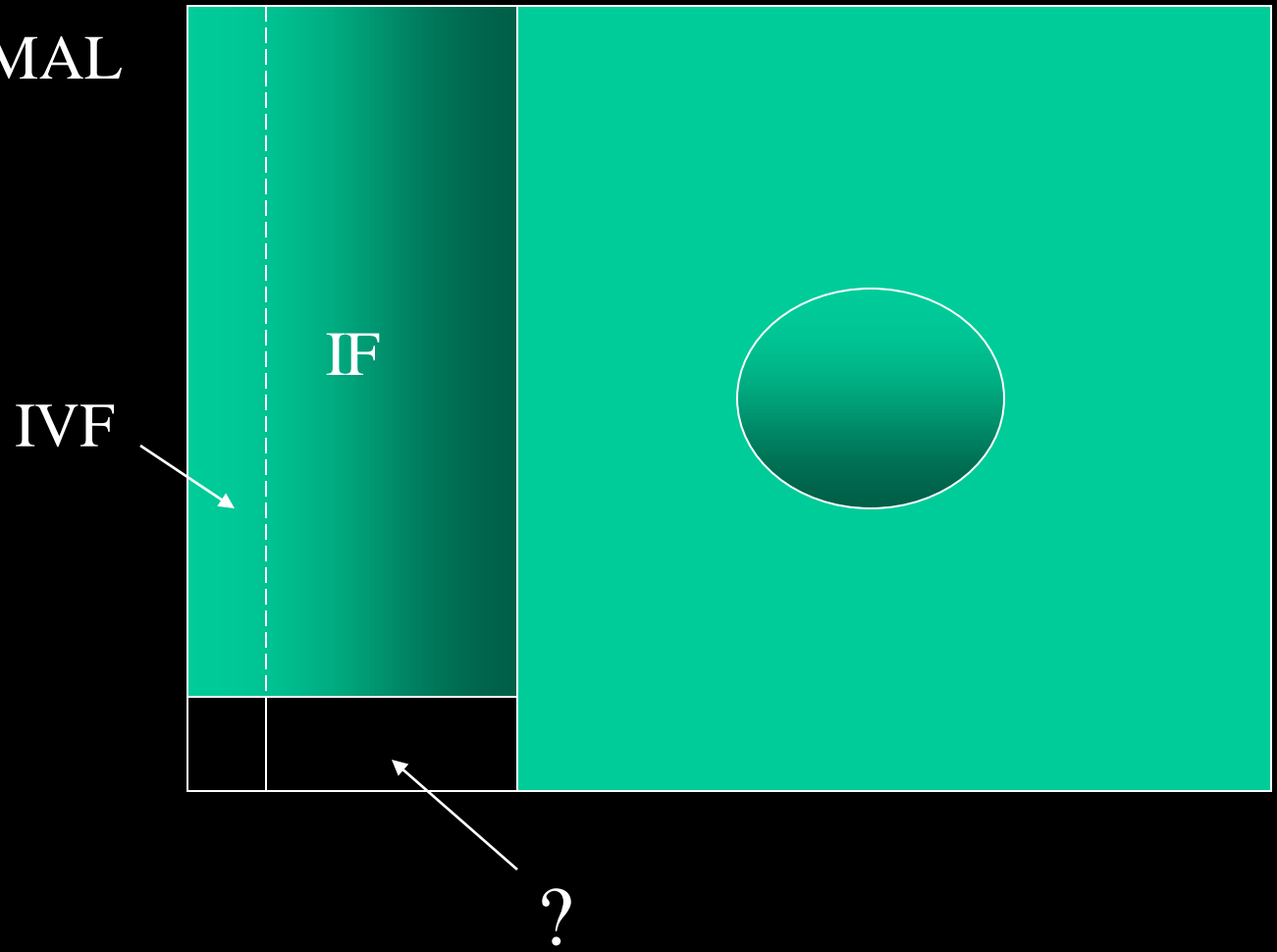
IF

HYPOVOLAMIA

NaCl DEFICIT

{ ECF } { ICF }

[Na+] NORMAL

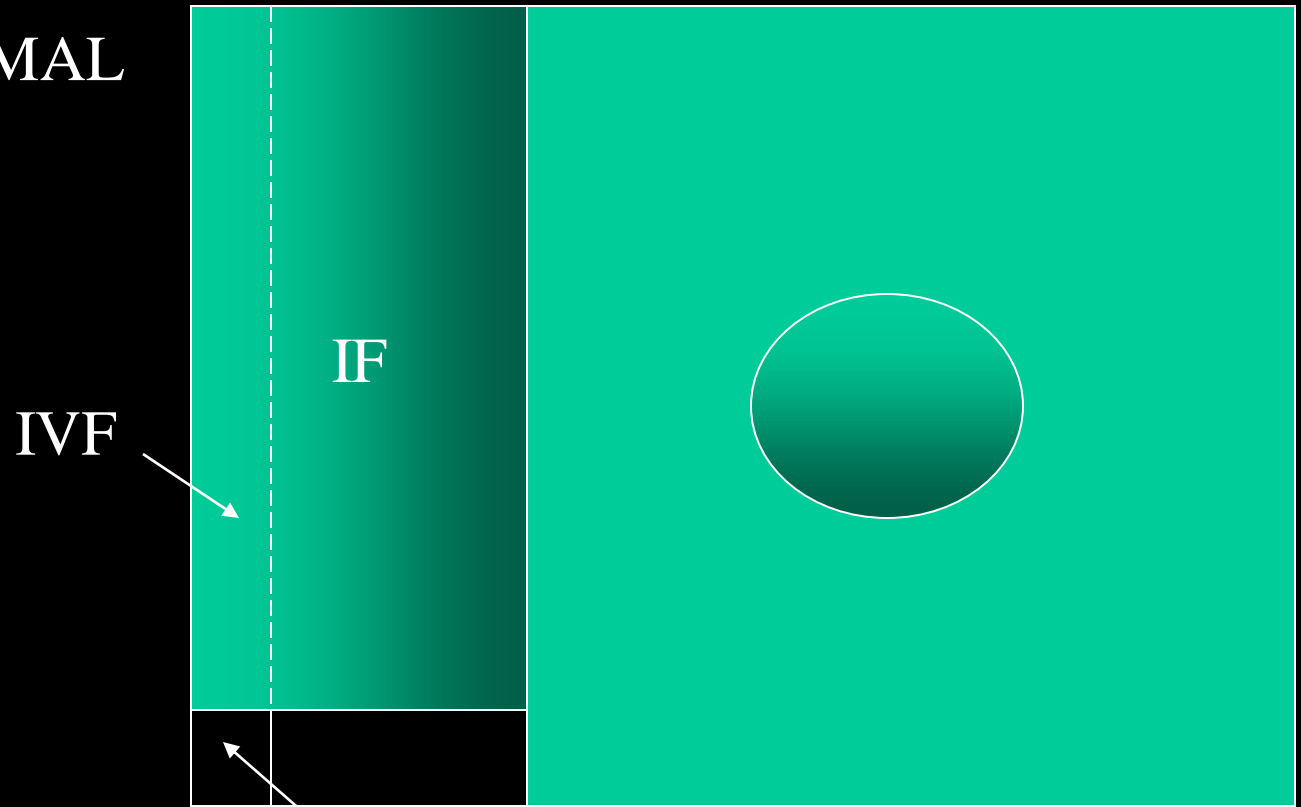


Pic of red skin turgor

NaCl DEFICIT

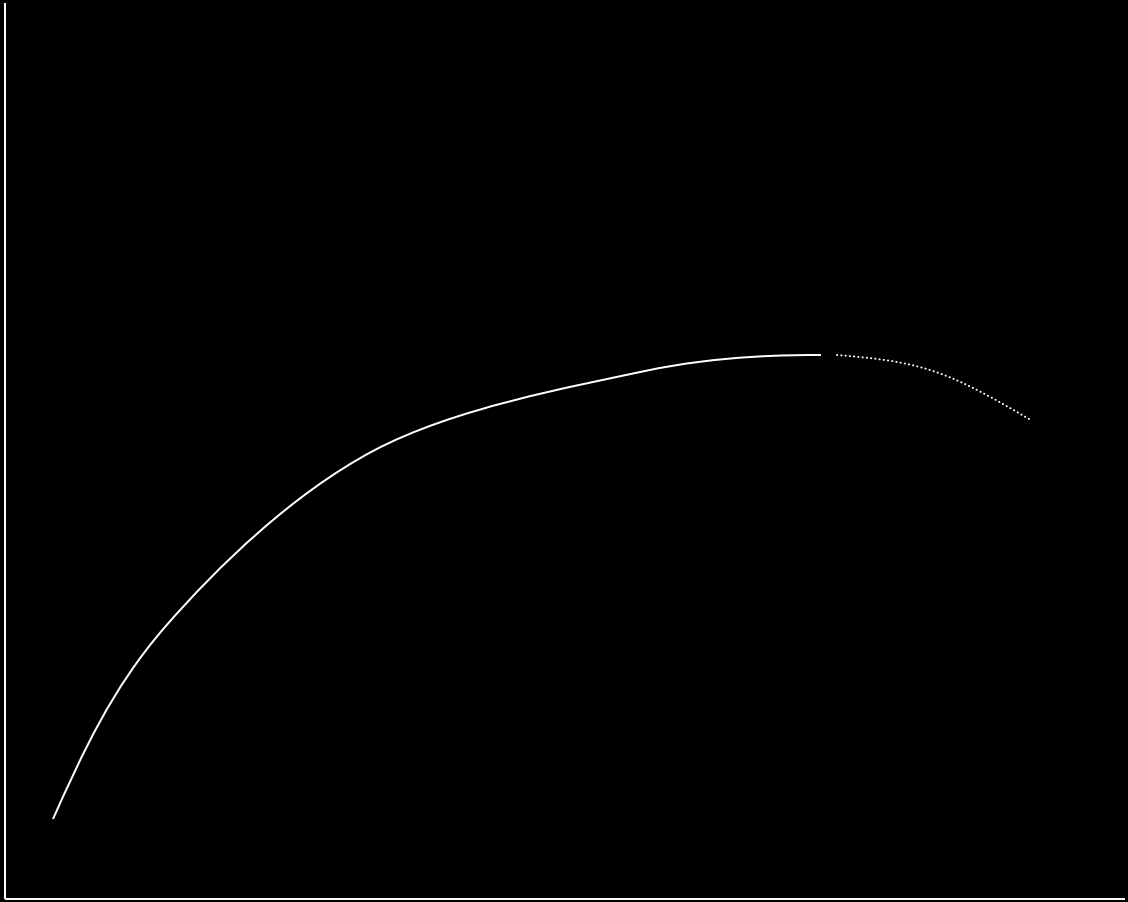
{ ECF } { ICF }

[Na+] NORMAL



?

CARDIAC  
OUTPUT



VENOUS RETURN

Na<sup>+</sup> content clinically

# Na<sup>+</sup> content clinically

ECF contraction



# Na<sup>+</sup> content clinically

ECF contraction

- Hypovolaemia
- Shock
- Skin turgor red.

# Na<sup>+</sup> content clinically

ECF contraction

• ECF expansion

- Hypovolaemia
- Shock
- Skin turgor red.

# Na<sup>+</sup> content clinically

ECF contraction

- Hypovolaemia
- Shock
- Skin turgor red.

• ECF expansion

- CVP/JVP
- Oedema

# Na<sup>+</sup> content clinically

ECF contraction

- Hypovolaemia
- Shock
- Skin turgor red.
- [Na]?

• ECF expansion

- CVP/JVP
- Oedema
- [Na]?

# Na<sup>+</sup> content clinically

ECF contraction

- Hypovolaemia
- Shock
- Skin turgor red.
- [Na]? *No*

• ECF expansion

- CVP/JVP
- Oedema
- [Na]? *No*

# Na<sup>+</sup> content clinically

ECF contraction

- Hypovolaemia
- Shock
- Skin turgor red.
- [Na]? *No*
- Renal dys.?

• ECF expansion

- CVP/JVP
- Oedema
- [Na]? *No*

# Na<sup>+</sup> content clinically

ECF contraction

- Hypovolaemia
- Shock
- Skin turgor red.

- [Na]? *No*
- Renal dys.? *Yes*

• ECF expansion

- Oedema
- CVP/JVP

- [Na]? *No*
- *(No)*

- Vomiting, diarrhoea
- Shocked



- Vomiting, diarrhoea
- Shocked

*“dehydrated”*

# Treat with:

- a NaCl 0.9%
- b Glucose 5%
- c Hartmann's
- d Sterile water
- e Glucose 50%
- f All of the above

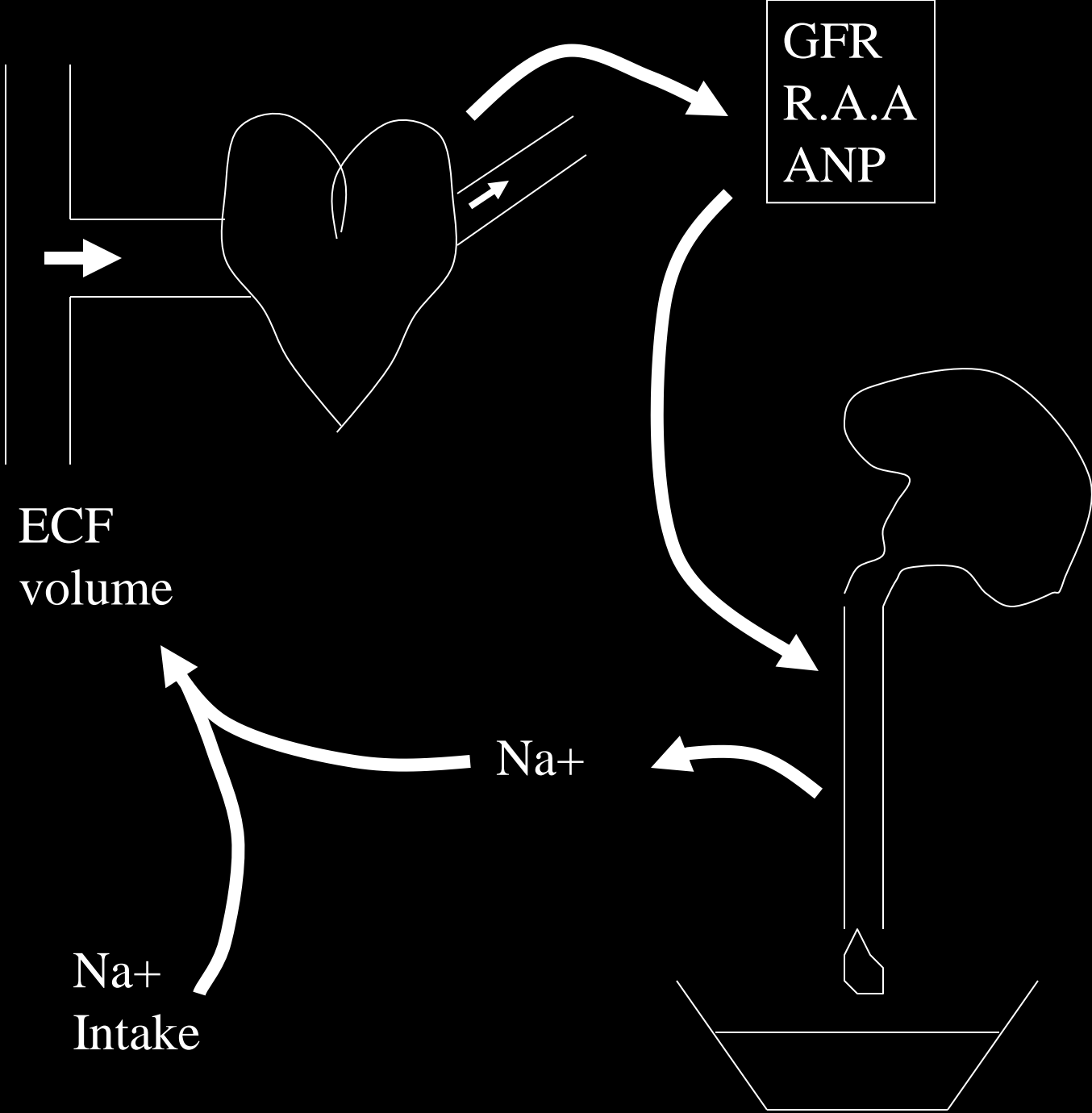
# MANTRAS

Na content  $\neq$  [Na]

**Na content**  $\rightarrow$  **ECF size**

Water content  $\rightarrow$  ICF size

Water content  $\propto$   $1/[Na]$



*ECF expansion?*

# *ECF expansion?*

- Na<sup>+</sup> excretion

# Terminology

# Terminology

- “fluid”



# Terminology

- “fluid”
  - Na containing water

# Terminology

- “fluid”
  - Na containing water
- “dehydrated”

# Terminology

- “fluid”
  - Na containing            water
- “dehydrated”
  - Water depleted?        Na depleted?

# Terminology

- “fluid”
  - Na containing                      water
- “dehydrated”
  - Water depleted?              Na depleted?
- “diuretic”

# Terminology

- “fluid”
  - Na containing                      water
- “dehydrated”
  - Water depleted?                      Na depleted?
- “diuretic”
  - Natriuretic?                      Water loss?

# MANTRAS

Na content  $\neq$  [Na]

Na content  $\rightarrow$  ECF size

Water content  $\rightarrow$  ICF size

Water content  $\propto$   $1/[Na]$

"I know you believe you understand what I said, but I am not sure you realise that what you heard is not what I meant"

Alan Greenspan

*If the patient is severely  
hyponatraemic or  
hypernatraemic,*

*you can be sure there is a doctor  
involved.*





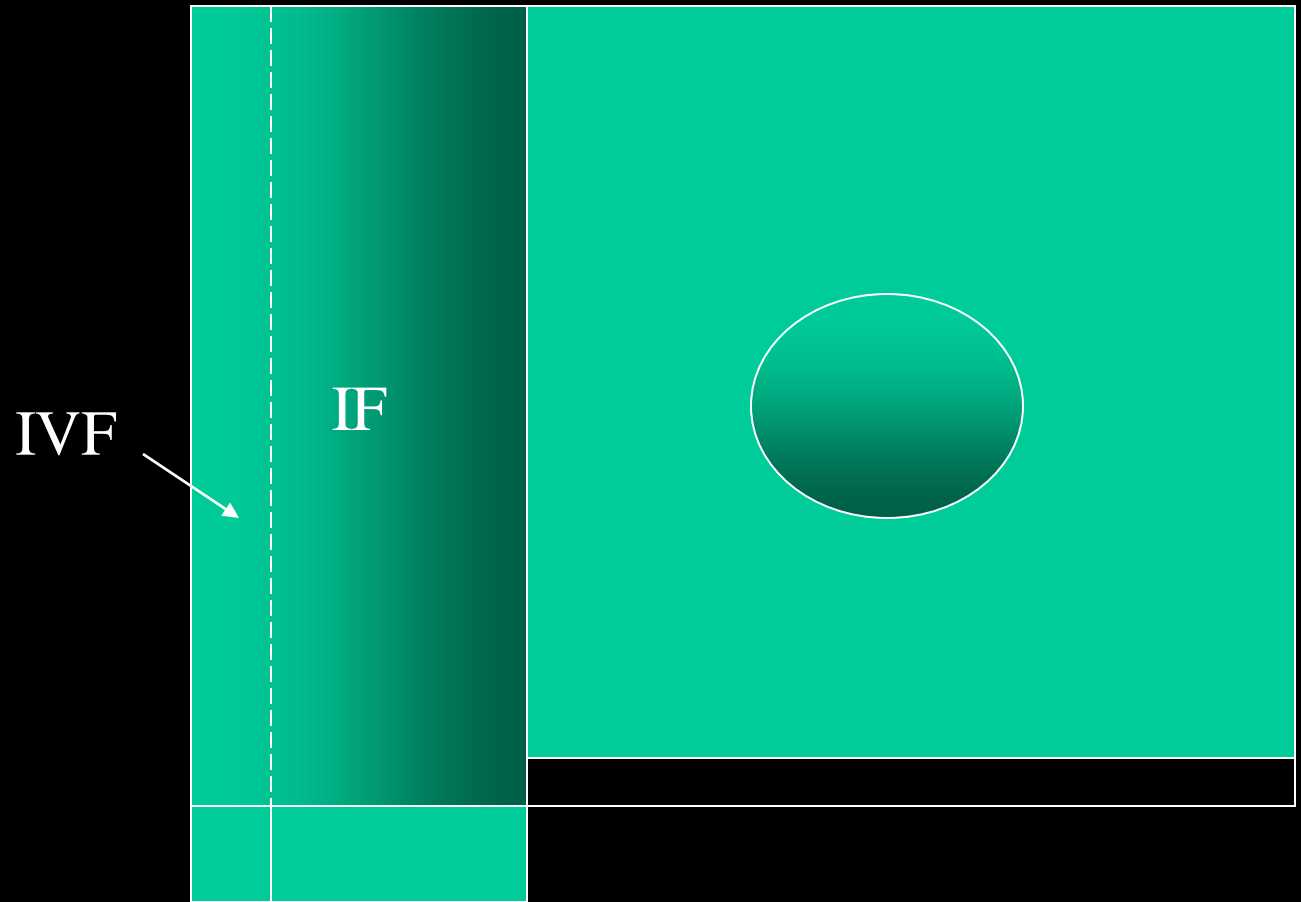
- **ECF expansion**

- Na<sup>+</sup> excretion

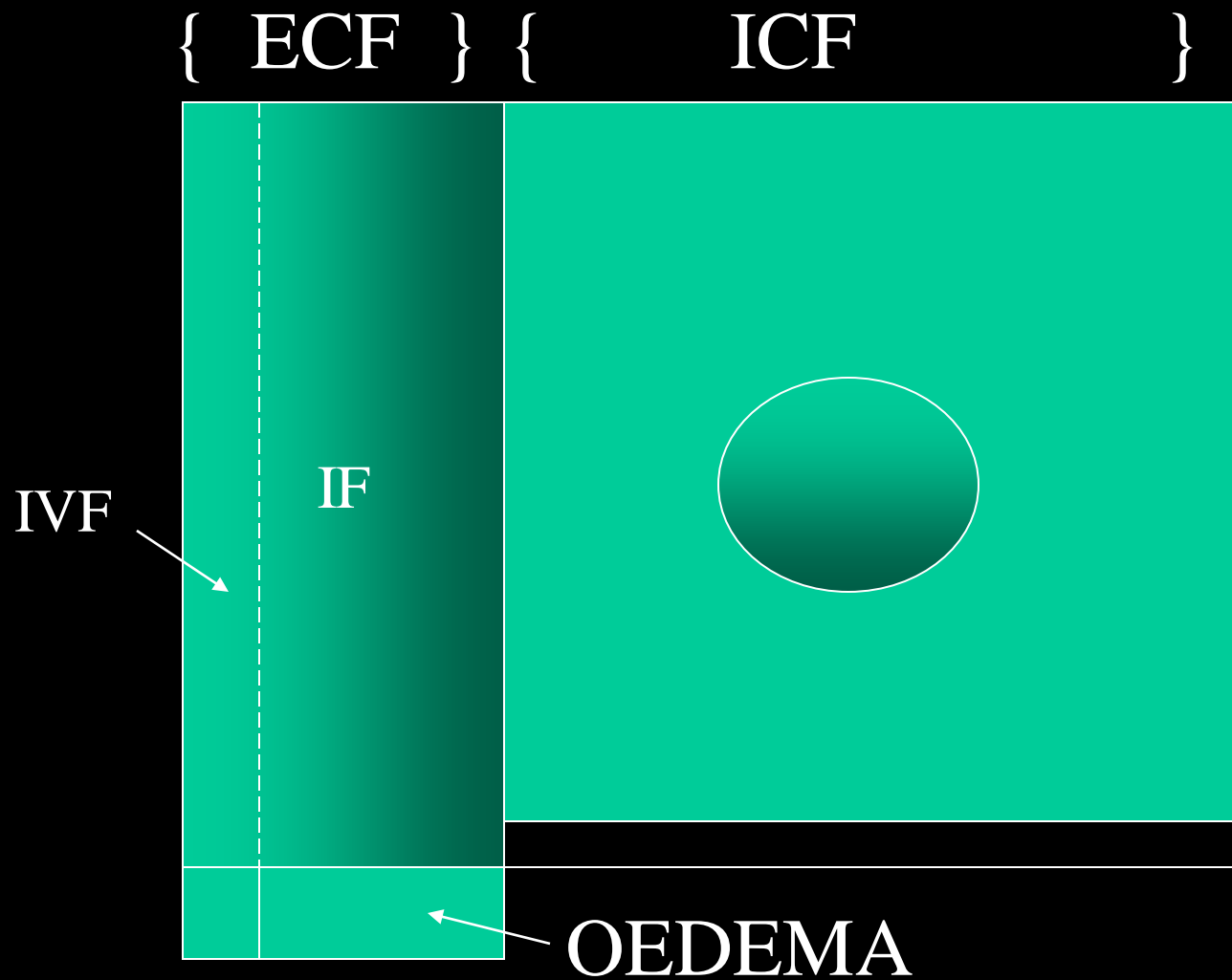
- **ECF contraction**

- Na<sup>+</sup> conservation

{ ECF } { ICF }



*It's the 'fluid' that does it...*



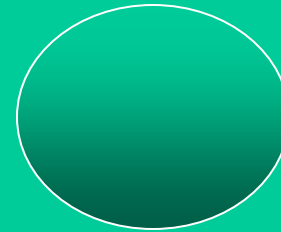
NaCl  
EXCESS

{ ECF } { ICF }

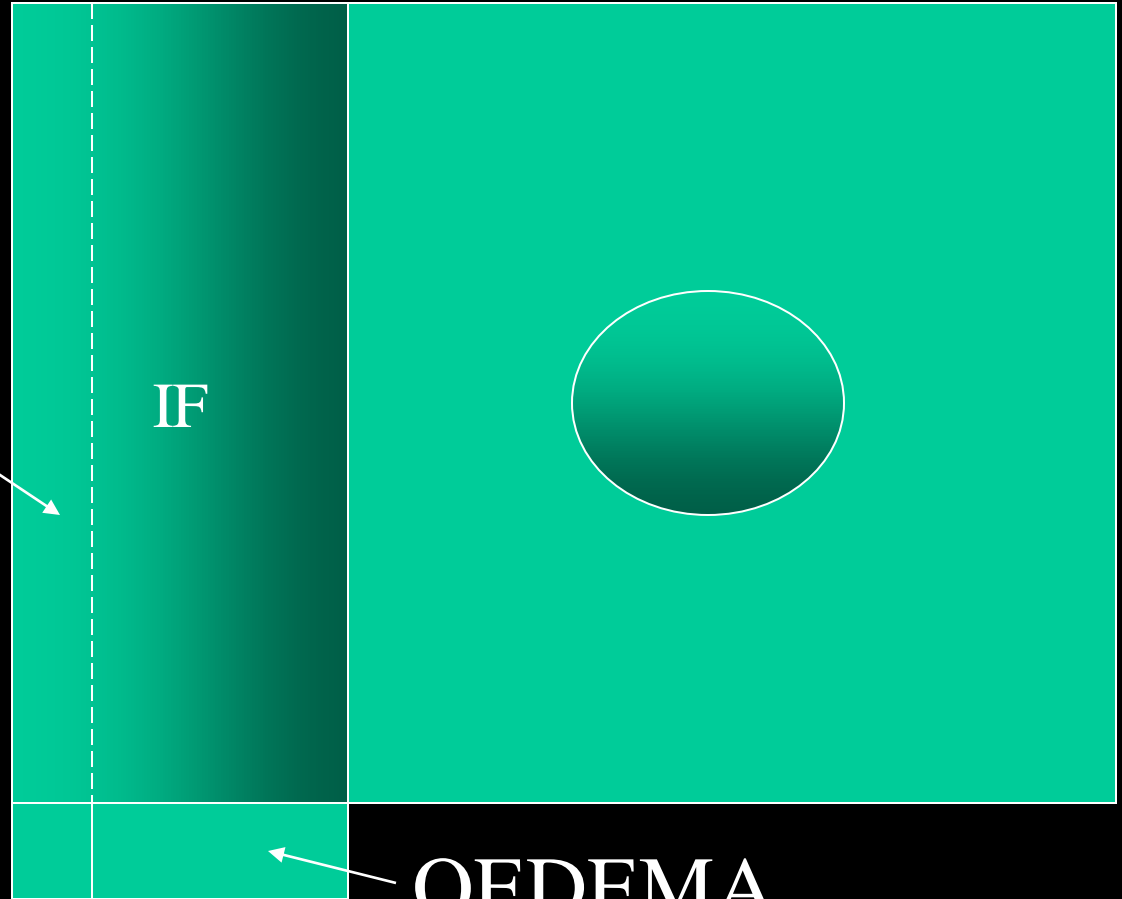
[Na+]  
NORMAL

IVF

IF



OEDEMA



# Na<sup>+</sup> excess: end result

- ECF expansion
- [Na<sup>+</sup>] normal

Na<sup>+</sup> content clinically



# Na<sup>+</sup> content clinically

ECF contraction

• ECF expansion

Na<sup>+</sup> excess in  
untreated patients?

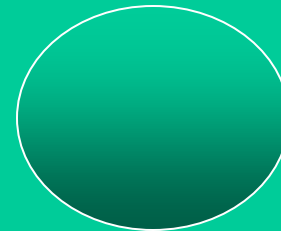
NaCl  
EXCESS

{ ECF } { ICF }

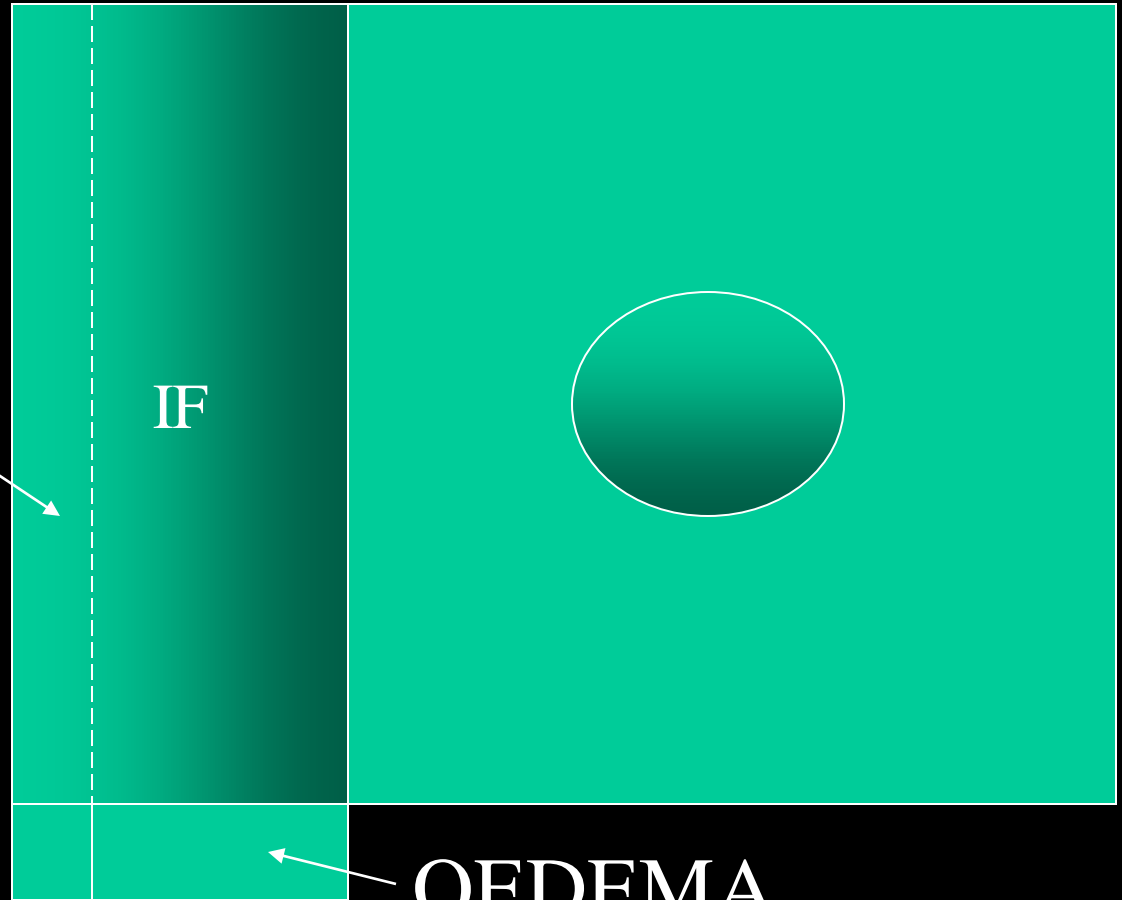
[Na+]  
NORMAL

IVF

IF

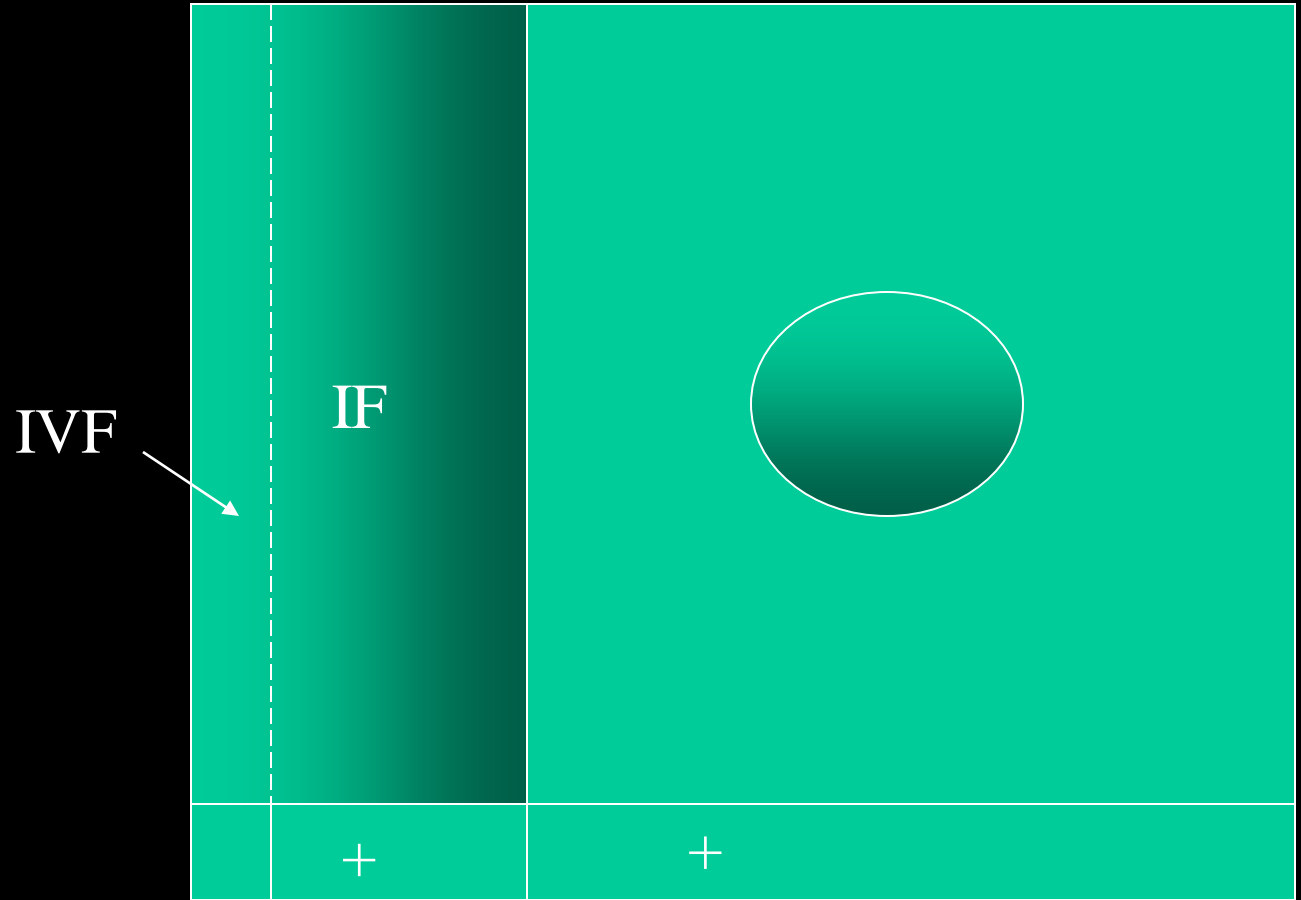


OEDEMA

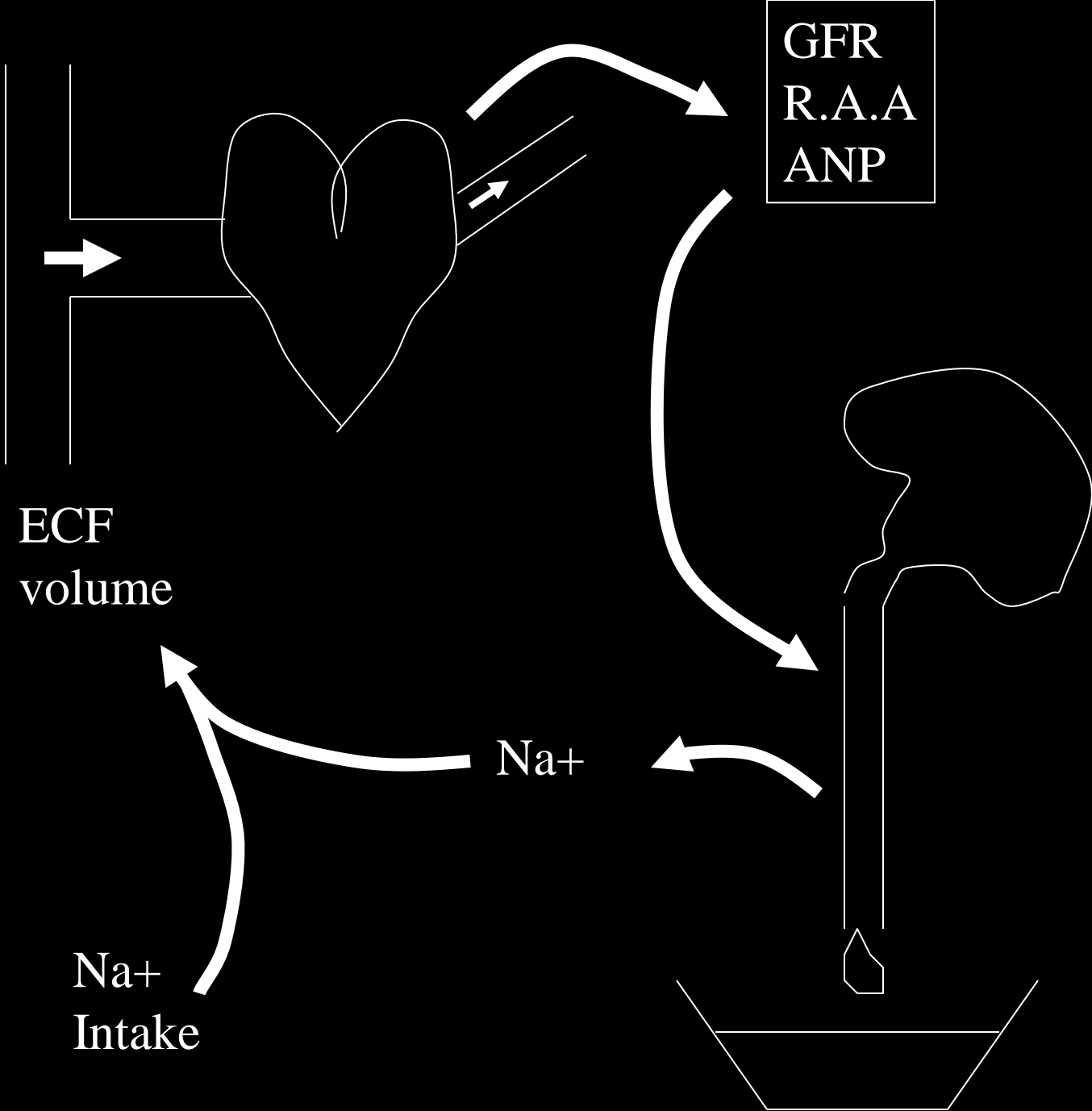


Water excess

{ ECF } { ICF }



*ECF expansion?*



# Water excess

- Dilutional hypo[Na<sup>+</sup>]
- Na<sup>+</sup> excretion
- Further hypo[Na<sup>+</sup>]



# SIADH criteria

WATER EXCESS

ICF EXPANSION

{ ECF } { ICF }

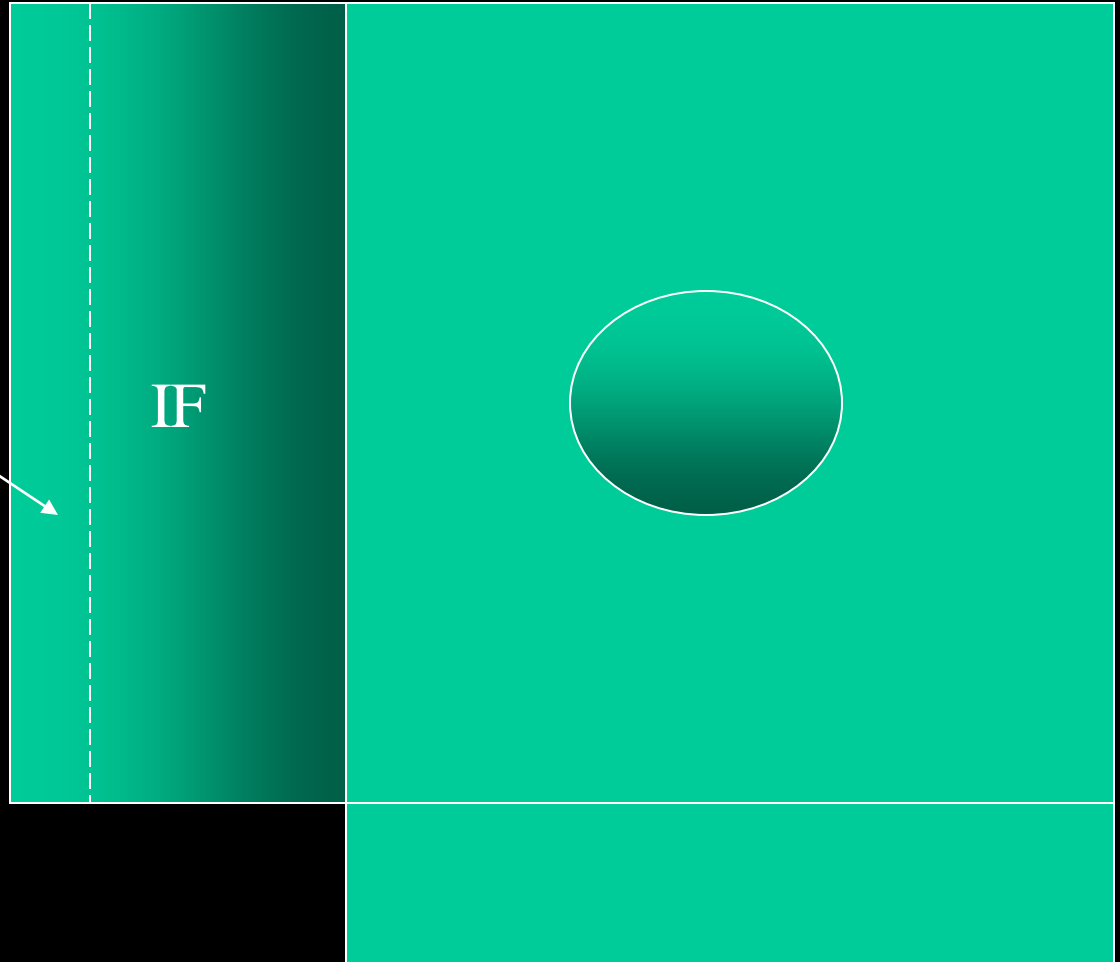
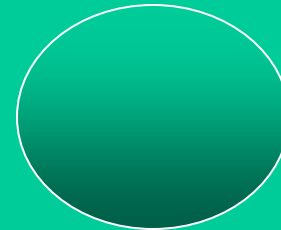
[Na+] DEC.

NORMOVOLAEMIA

IVF



IF



# MANTRAS

Na content  $\neq$  [Na]

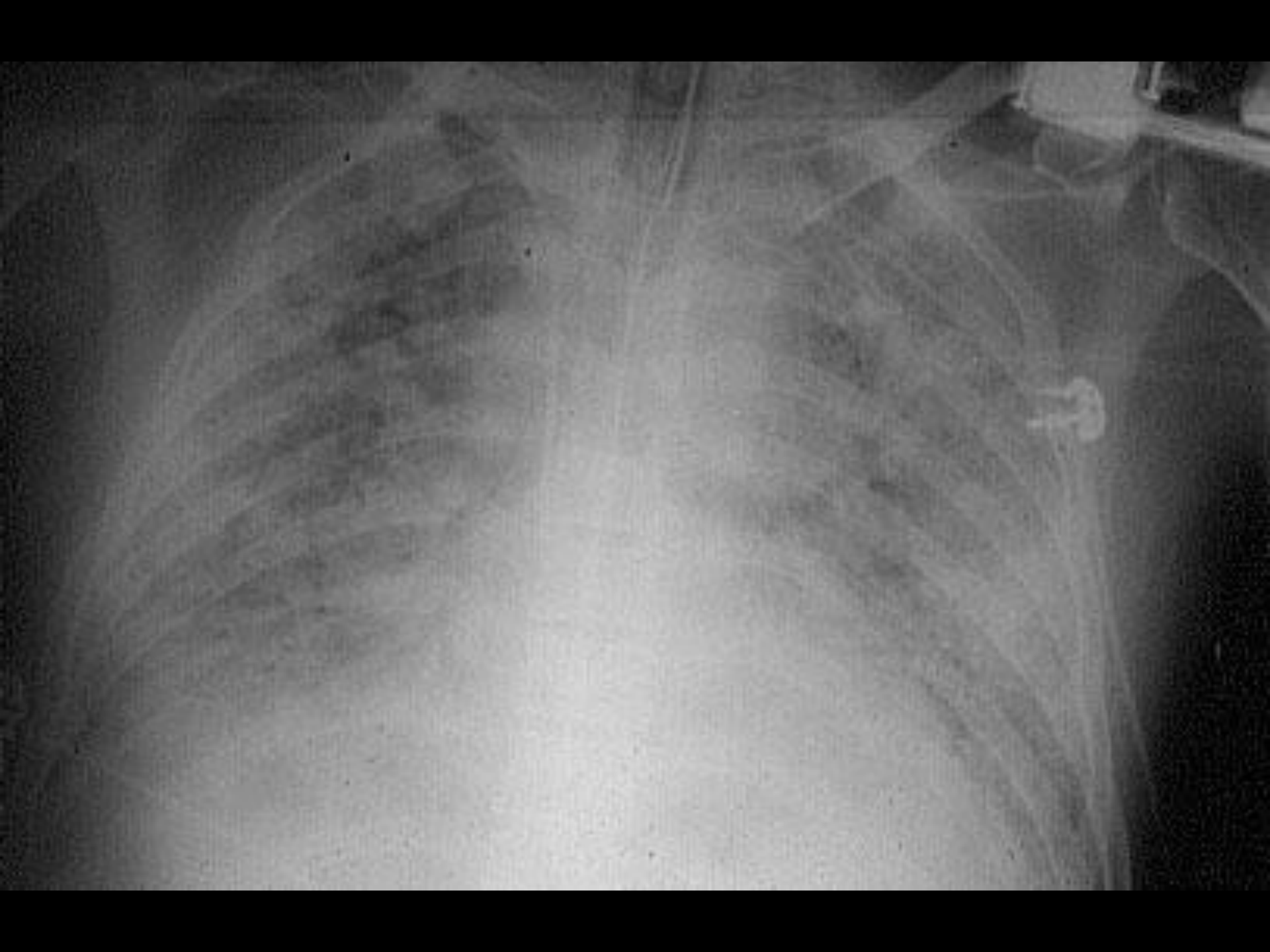
Na content  $\rightarrow$  ECF size

**Water content  $\rightarrow$  ICF size**

# Clinically

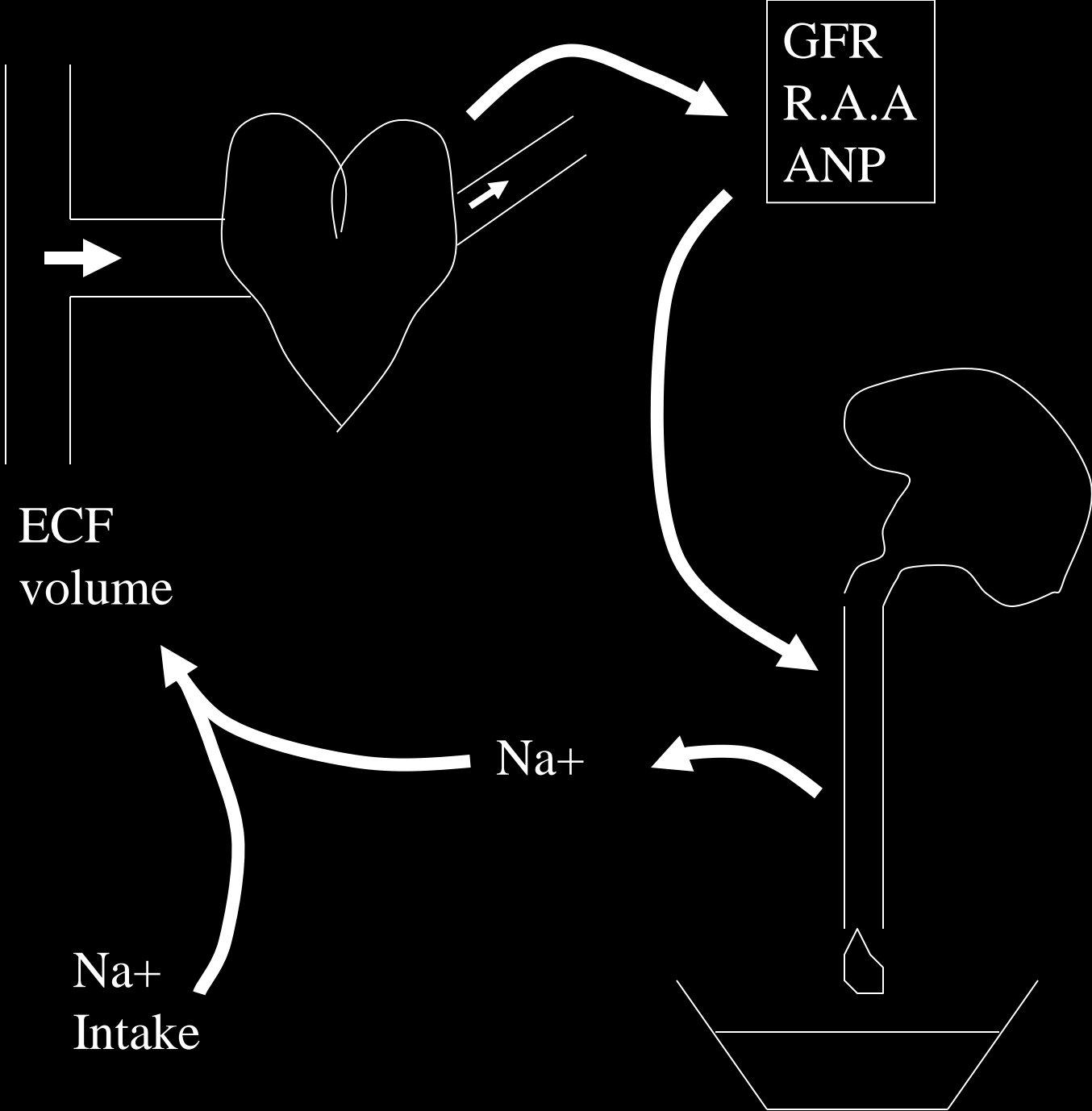
- **Water excess:**
- ICF expansion
- *Hypo*[Na<sup>+</sup>]
- **Water deficit:**
- ICF contraction
- *Hyper*[Na<sup>+</sup>]

Example:



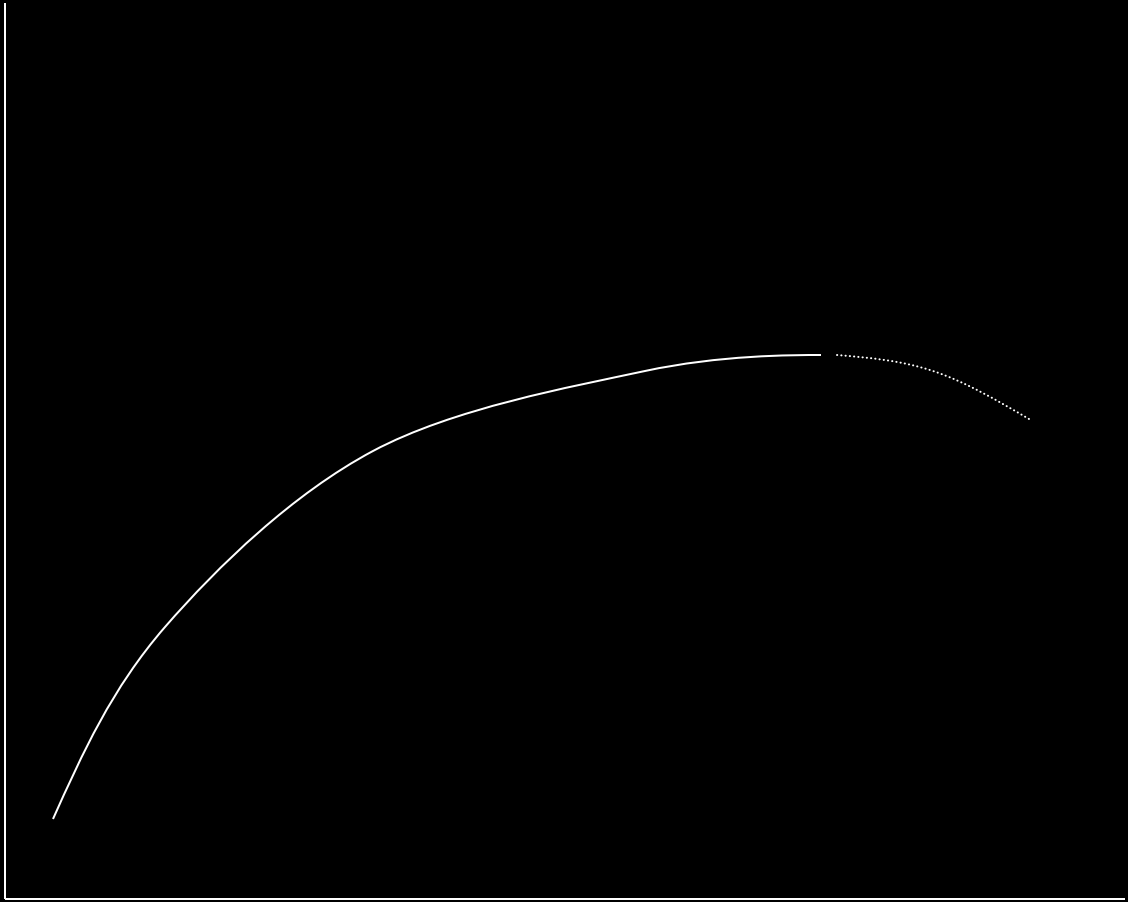
# “Fluid”

- *Gas or liquid*
- *Intravenous liquid*





CARDIAC  
OUTPUT



VENOUS RETURN

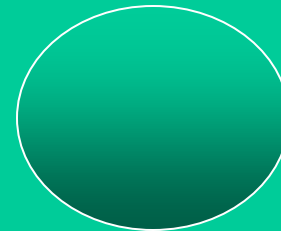
NaCl  
EXCESS

{ ECF } { ICF }

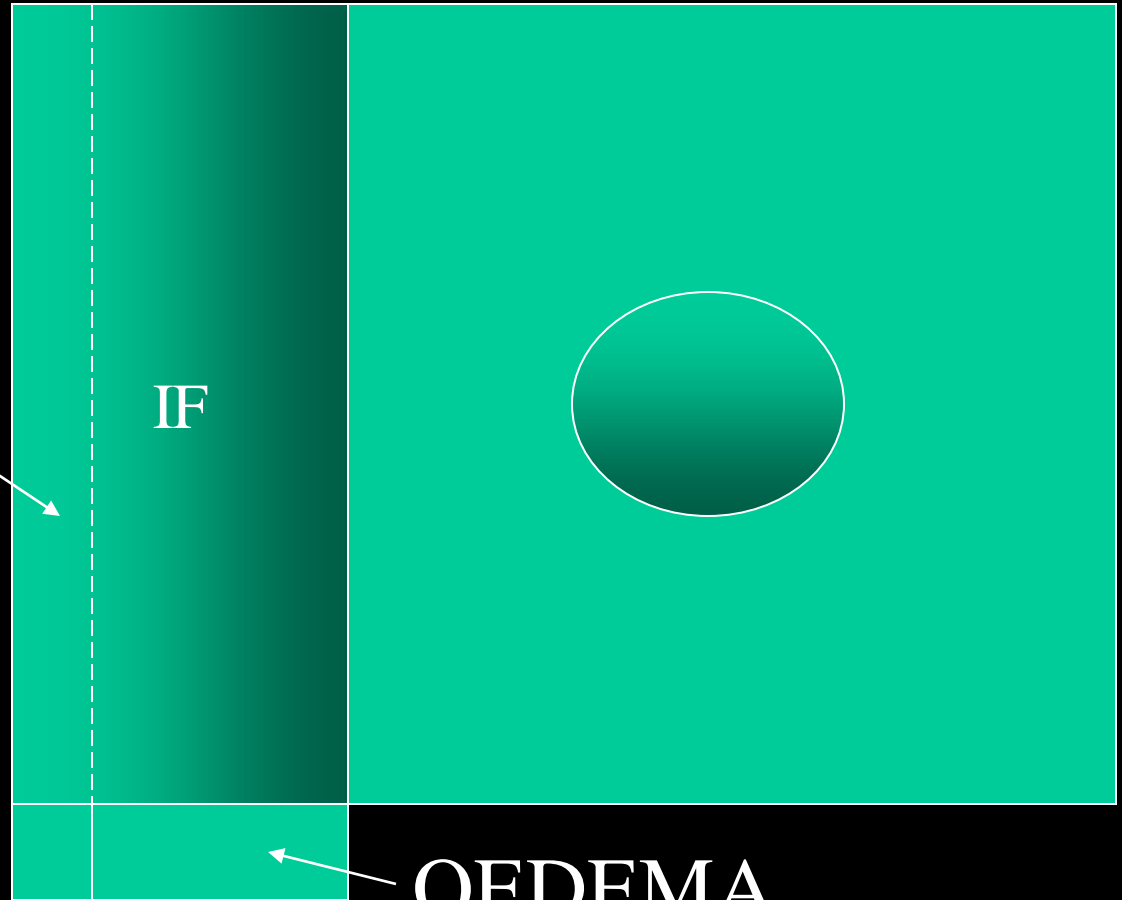
[Na+]  
NORMAL

IVF

IF



OEDEMA



# Example:

- Vomiting & diarrhoea
- Hypotension
- Oliguria
- Cold peripheries

*“Dehydration”*

# Classification

- Sterile water
- Glucose 5%
- Hartmann's
- NaCl 0.9%
- Gelatin
- Albumin

Example:

# WATER INTOXICATION:

# WATER INTOXICATION:

*Pulmonary oedema?*



WATER EXCESS

ICF EXPANSION

{ ECF } { ICF }

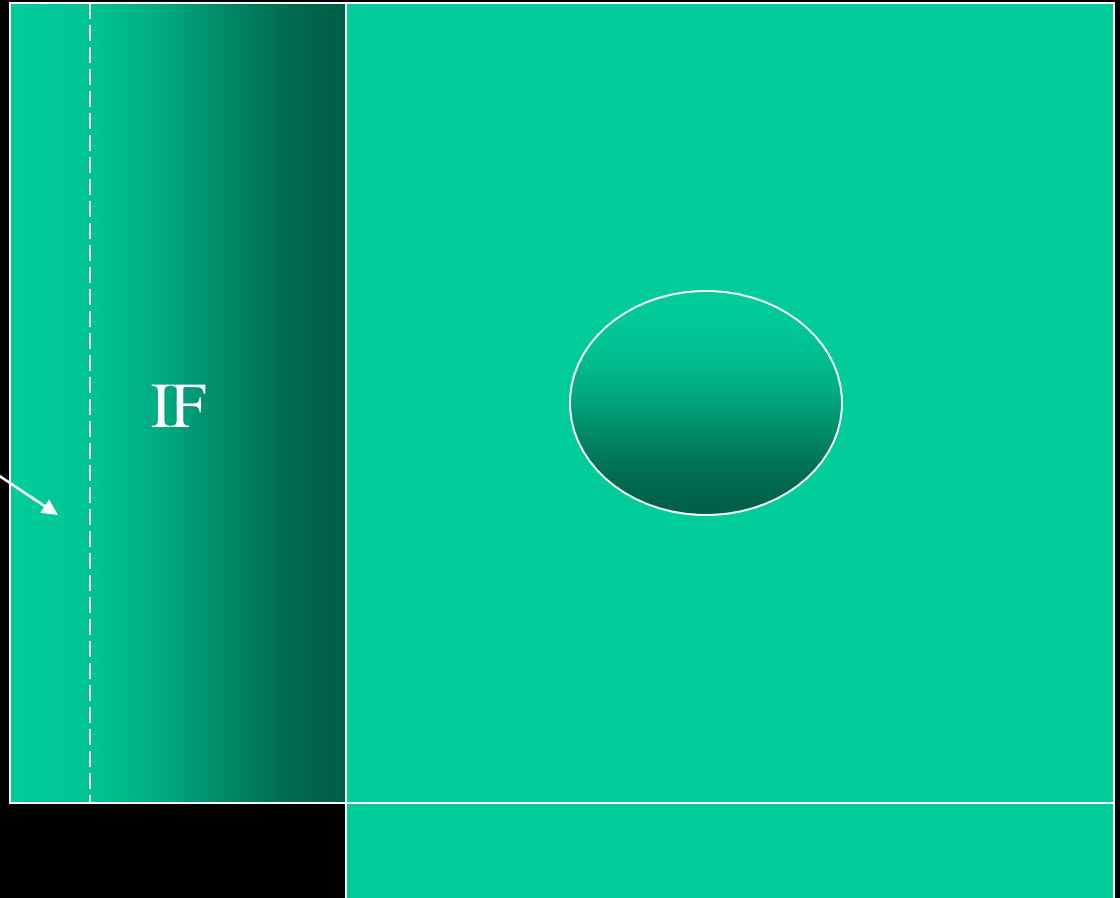
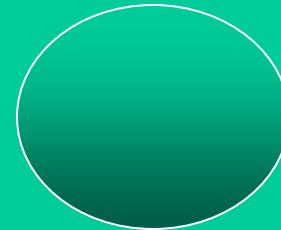
[Na+] DEC.

NORMOVOLAEMIA

IVF



IF

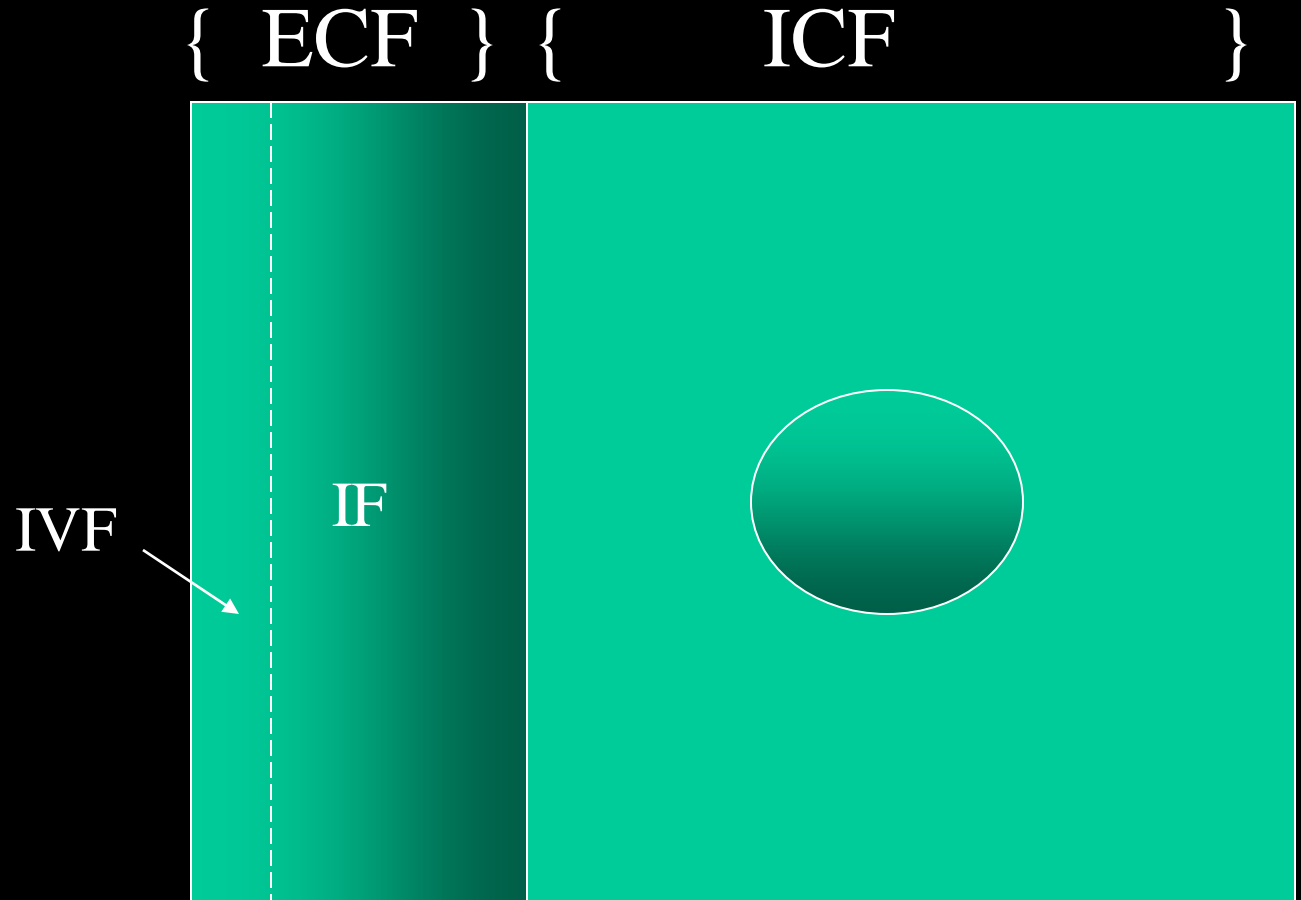


Example:

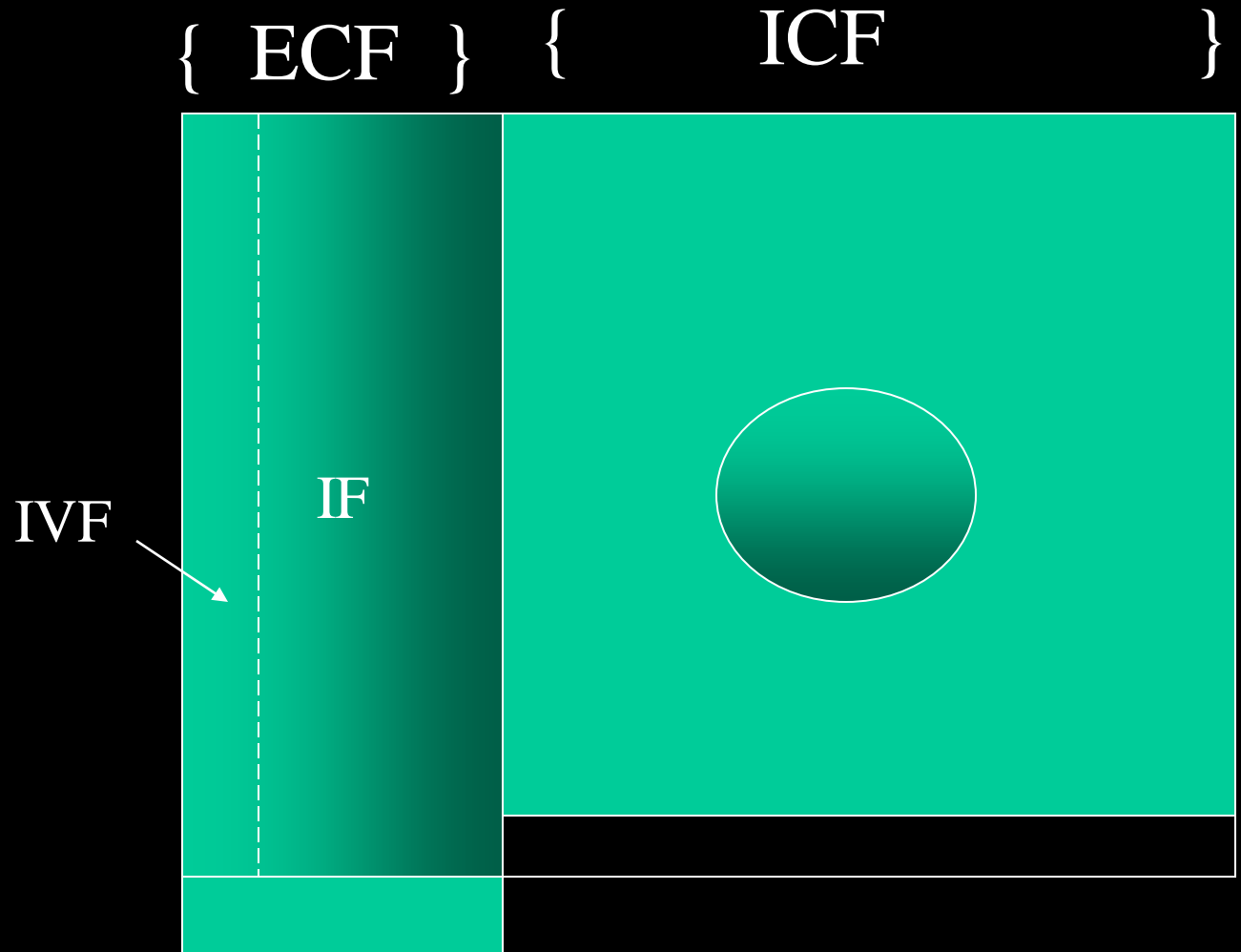
deliberate ICF contraction

Mannitol

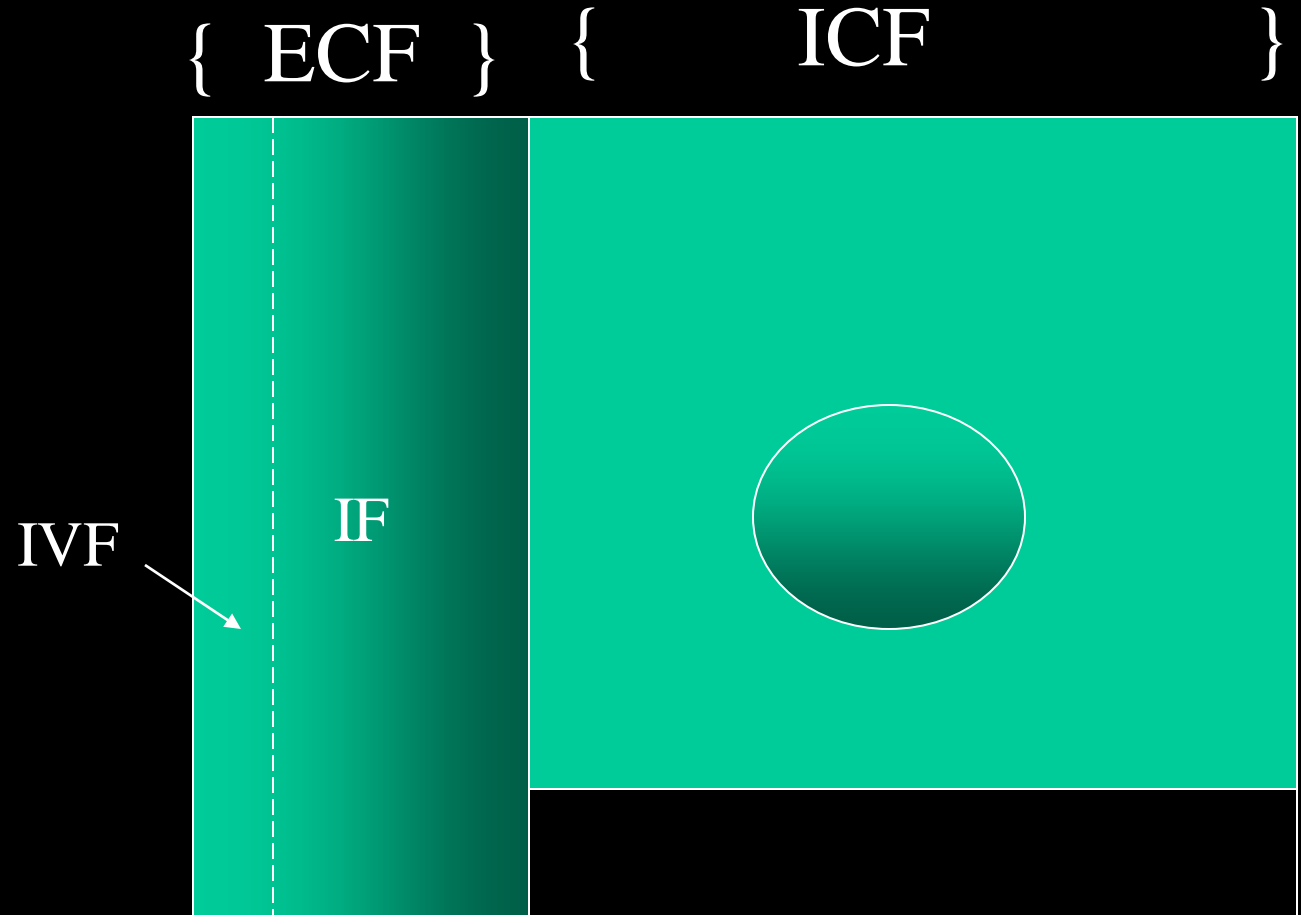
Normal



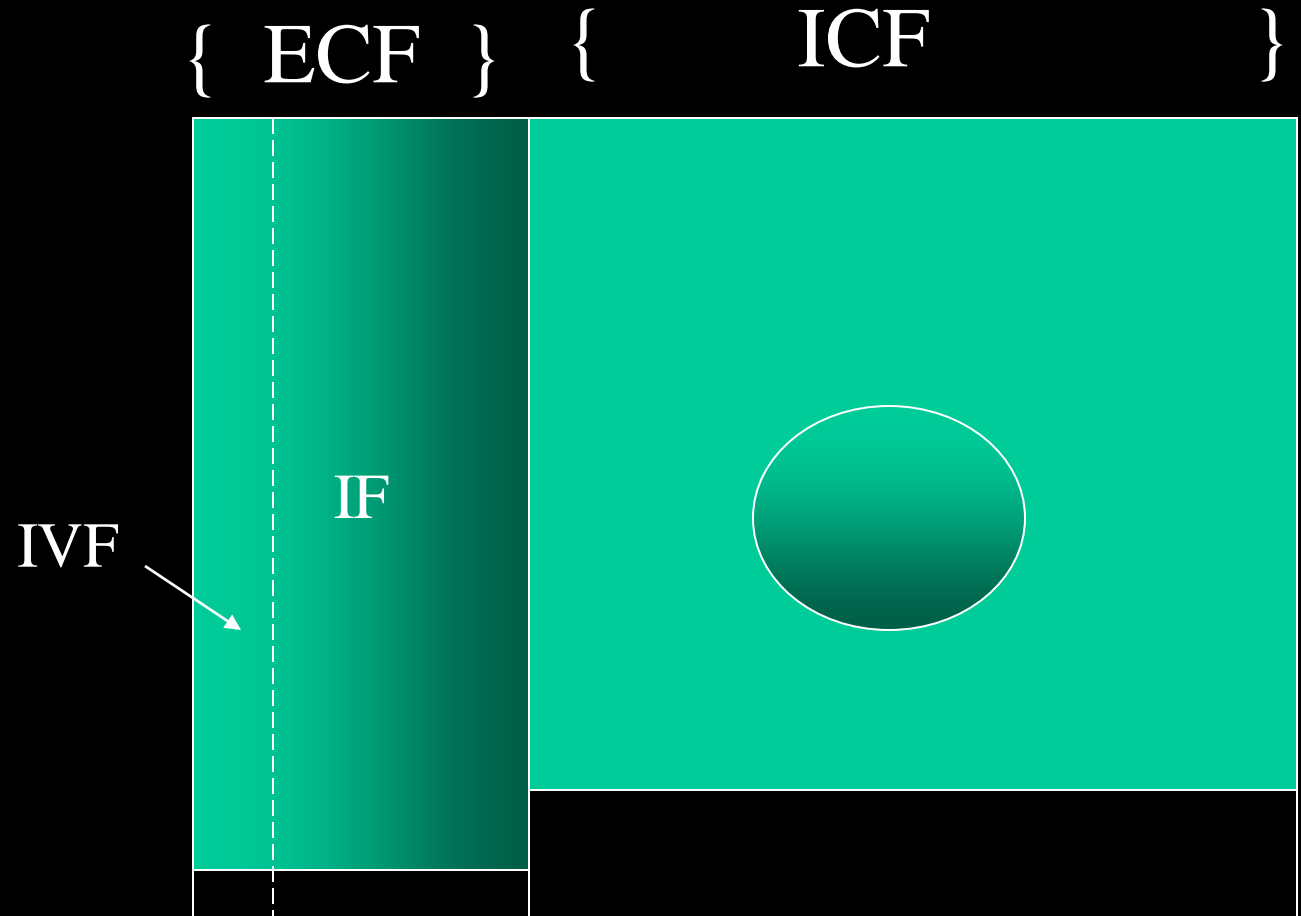
Mannitol: immediate



# Mannitol: with diuresis



Mannitol: later?

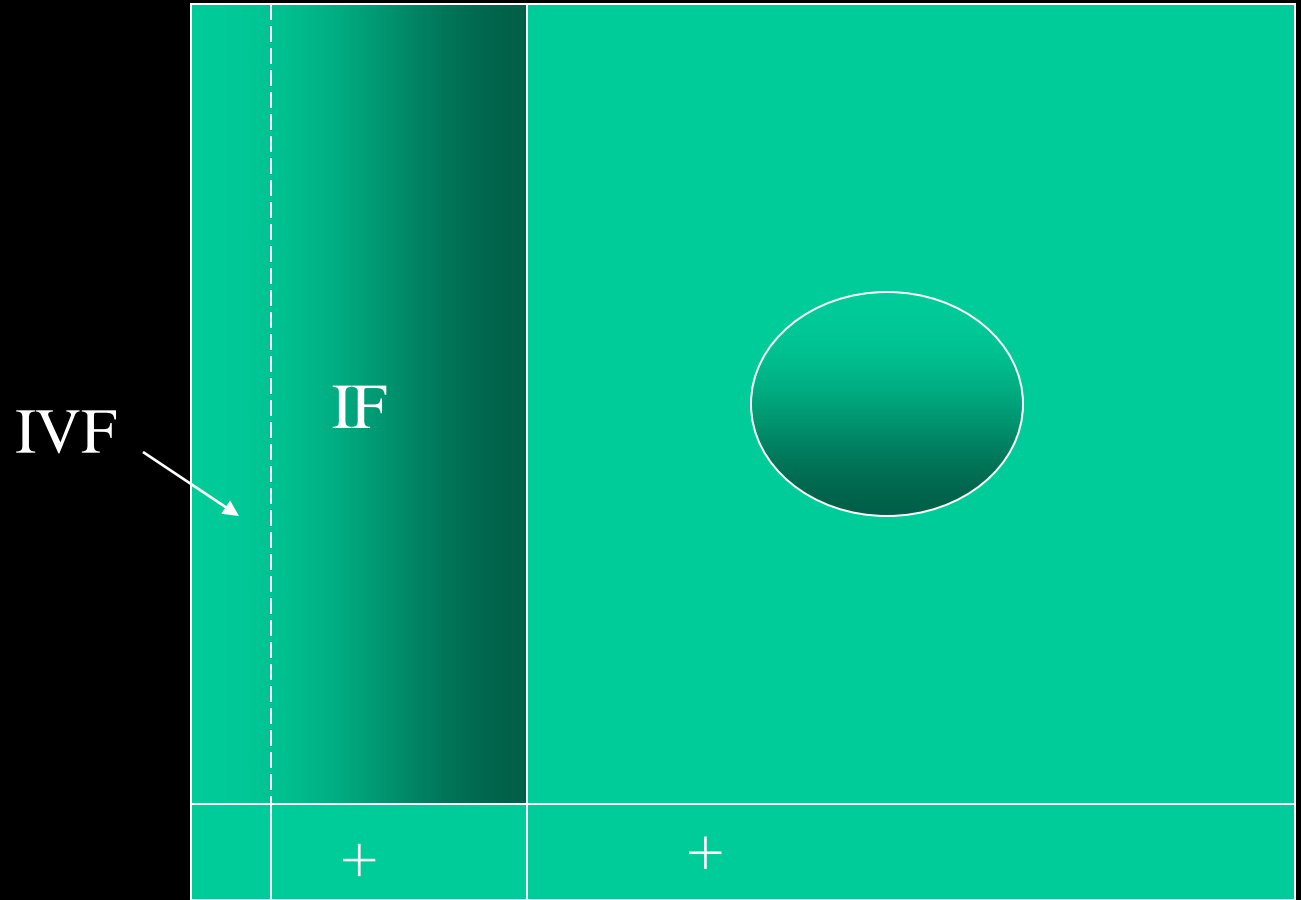


# (Second last) Example

- Renal failure
- +10L water
- ???

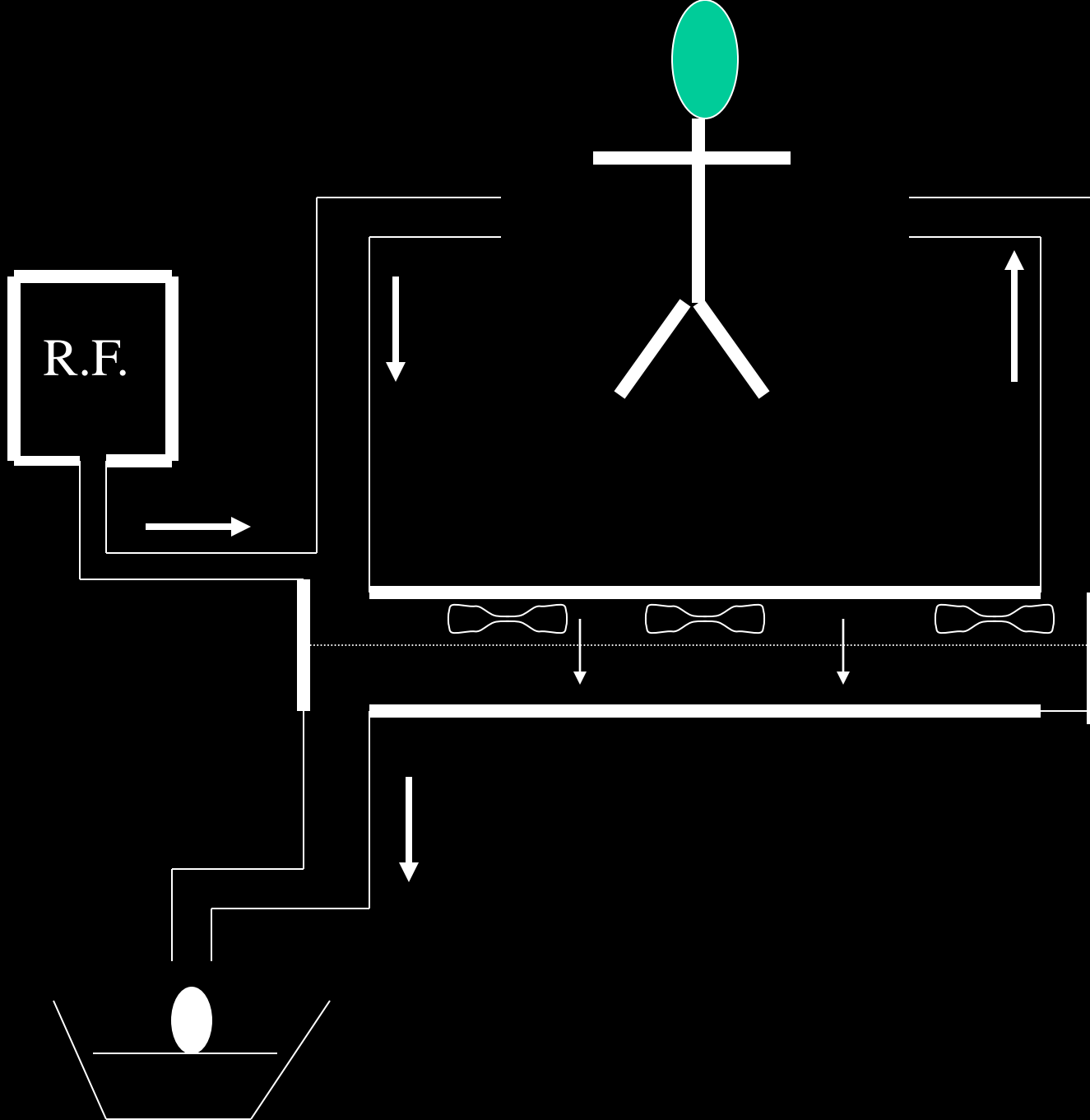


{ ECF } { ICF }



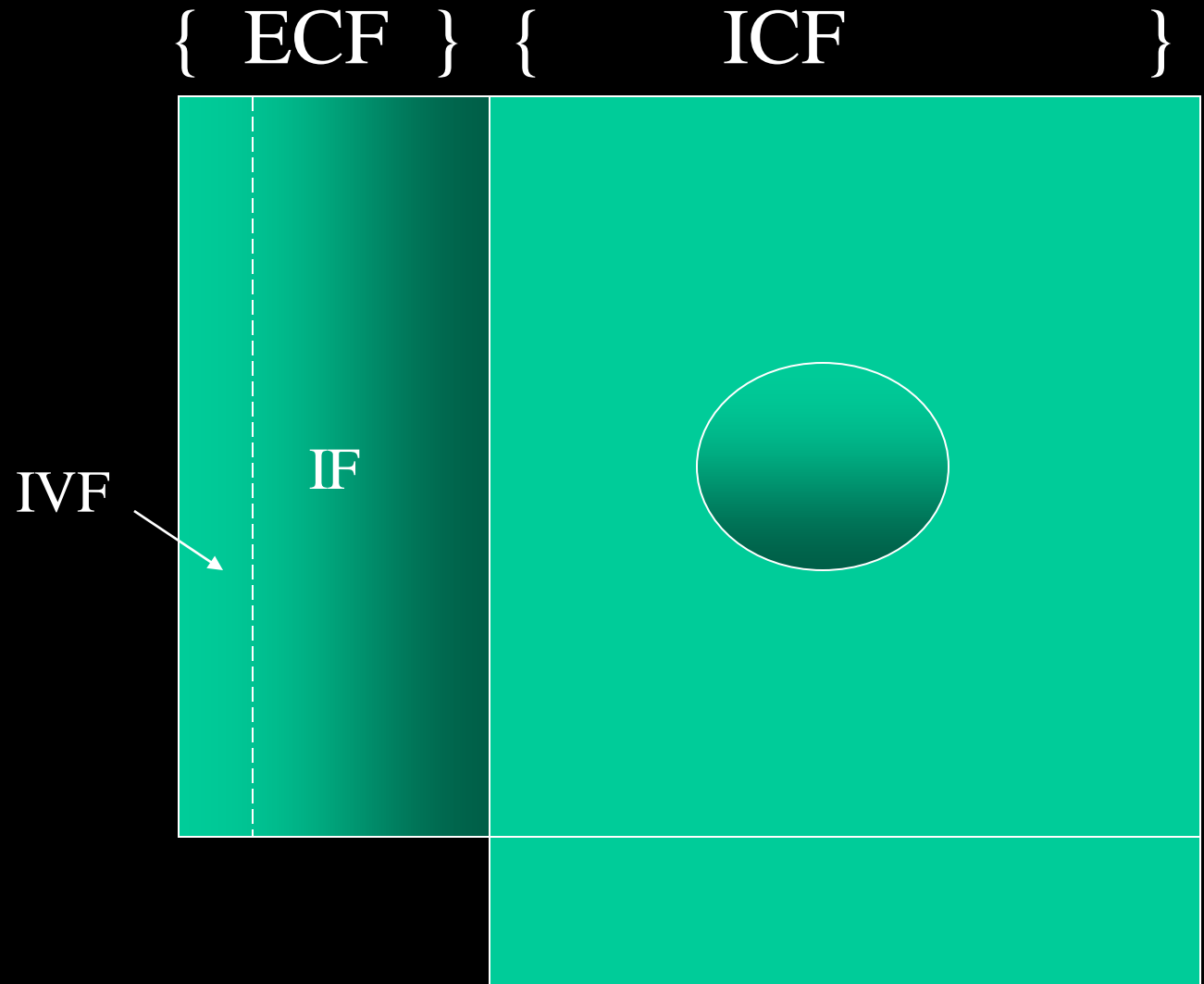
# (Last) Example

- Renal failure
- Hypo[Na<sup>+</sup>] 110 mMol/L
- Normovolaemic
- CRRT
  
- ??



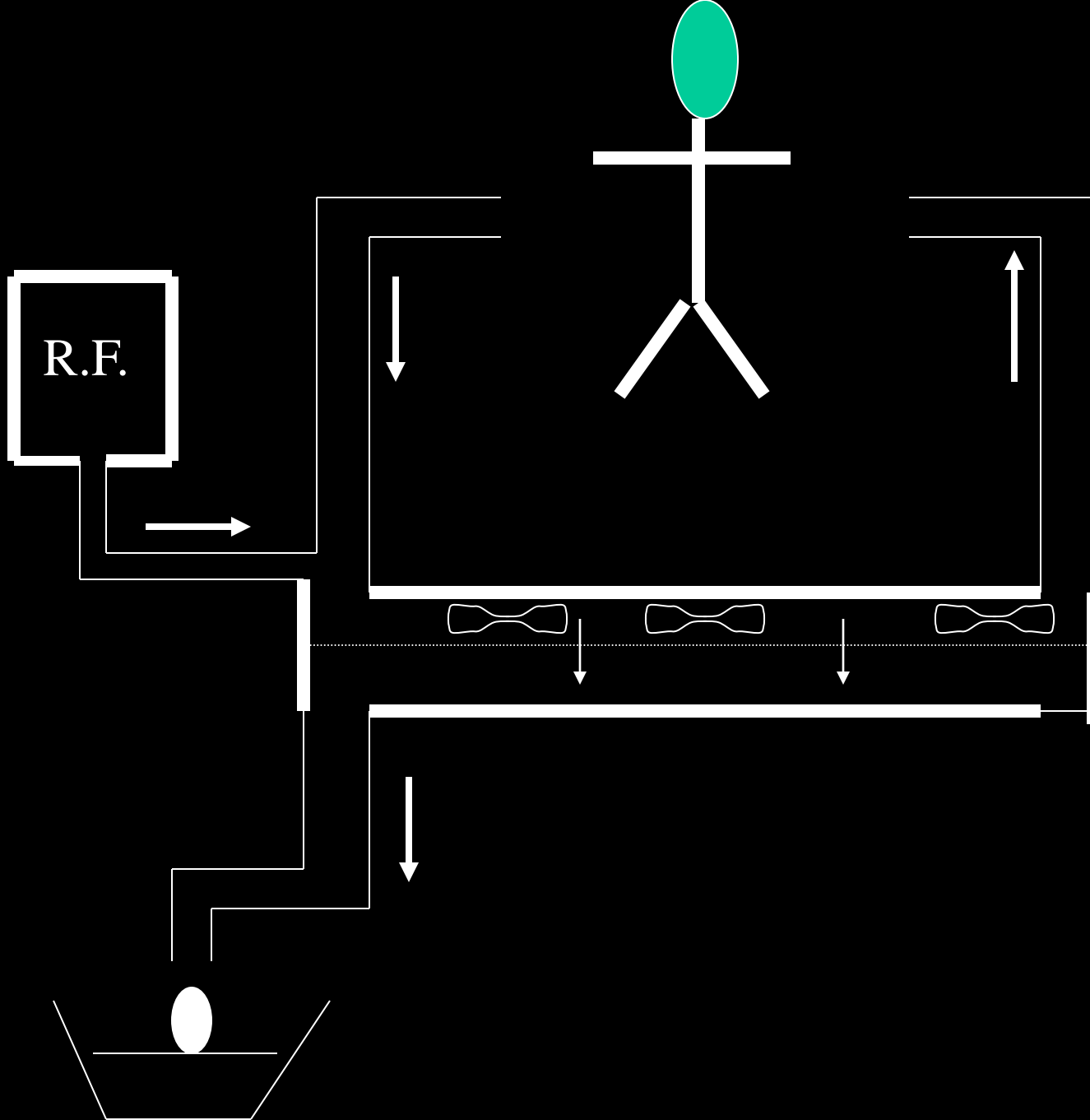
?

Before CRRT



Hypo[Na<sup>+</sup>].....Normo[Na<sup>+</sup>]

CRRT effect on Na<sup>+</sup> balance?



*Giving Na<sup>+</sup> to the patient!!!*



With CRRT, 'fluid' removal 0

