

運動生化學服務的最新發展

Latest Developments in Sport Biochemistry Servicing

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運動生化服務範圍

Overview of the Sport Biochemistry Service

- 監控恢復
 - 監察健康狀況
 - 評定身體機能
 - 量化運動強度
- Recovery monitoring
 - Health monitoring
 - Evaluation of training status
 - Quantification of training intensity

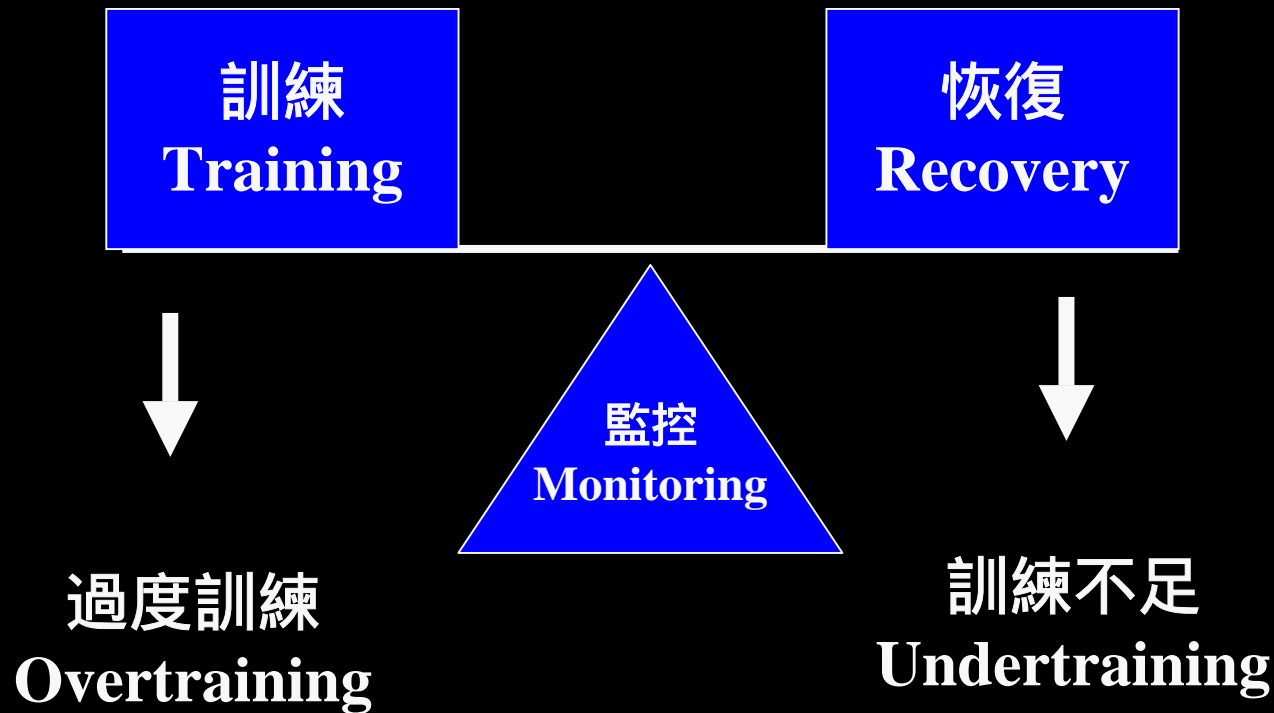
其他應用

Other Applications

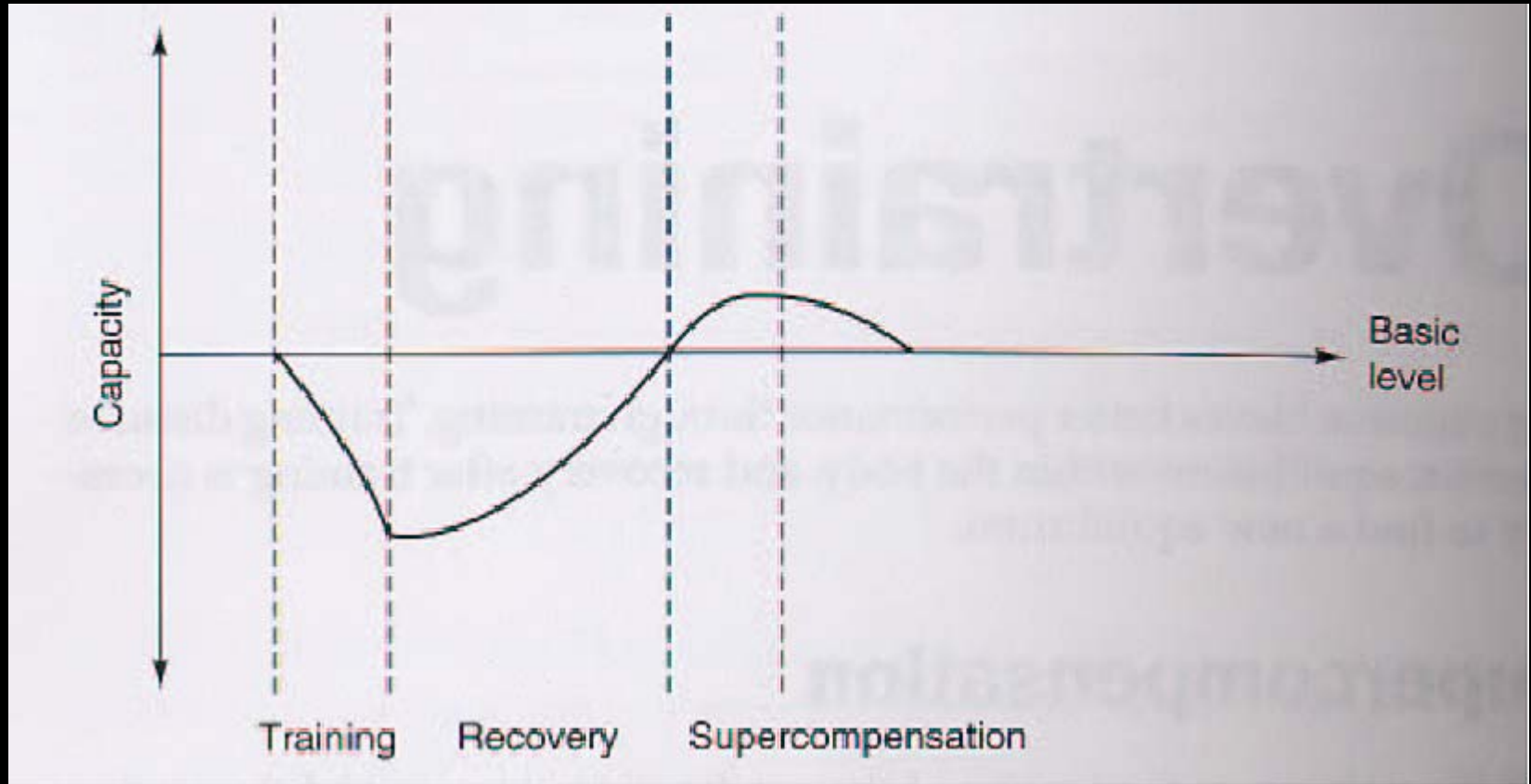
- 高原訓練 / 低氧艙
- 比賽心理壓力
- 鐵貯備
- 水平衡
- Altitude training / Hypoxic stress
- Pre-competition stress
- Iron status
- Hydration status

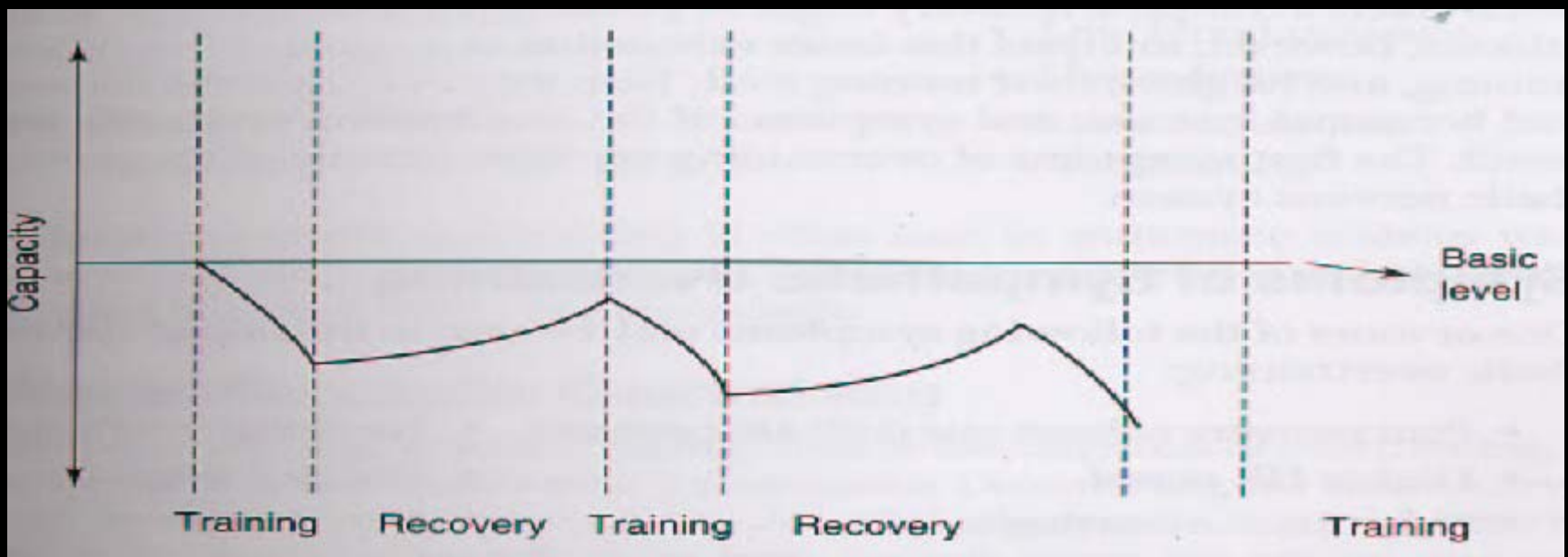
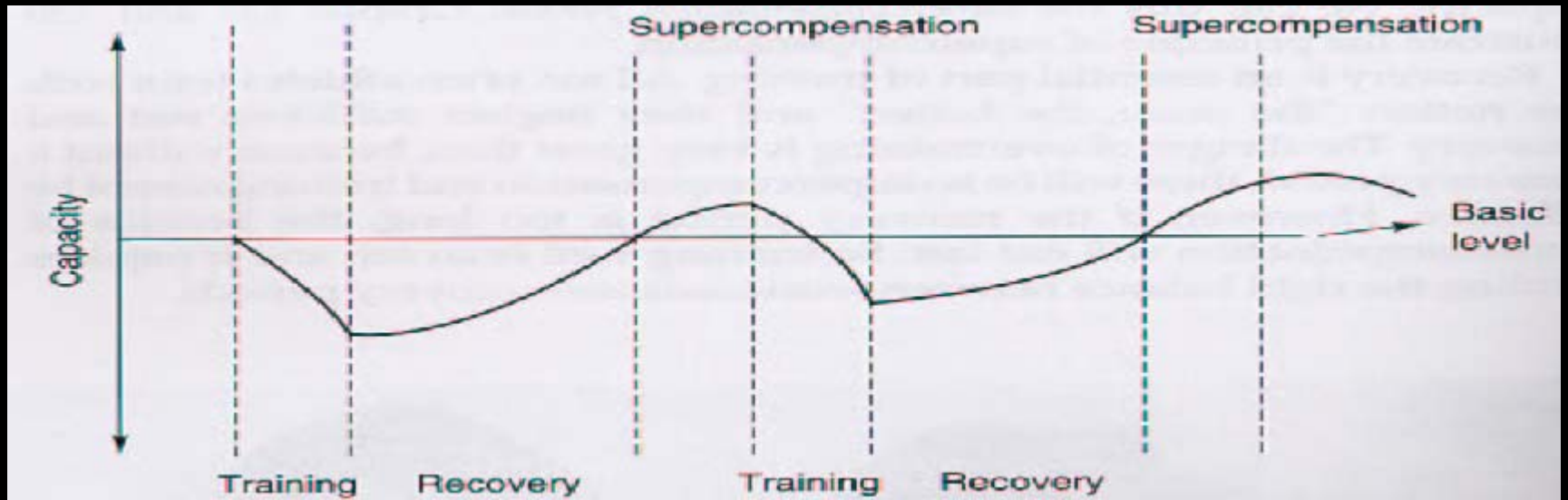
監控恢復

Recovery Monitoring



Supercompensation





監控恢復常用的指標

Parameters used for recovery monitoring

- CK
- 尿素
- 尿酸
- 血色素
- 睪酮
- 皮質醇
- Creatine kinase (CK)
- Urea
- Uric Acid (UA)
- Haemoglobin (Hb)
- Testosterone (T)
- Cortisol (C)

血清睪酮及皮質醇在監控恢復的應用

Application of serum testosterone & cortisol in training monitoring

(Hakkinen et al, 1987)

- 一年跟蹤研究
 - 11名精英舉重運動員
 - 增加訓練
 - 睪酮下降
 - 睪酮/皮質醇下降
 - 減少訓練
 - 睪酮不變
 - 皮質醇下降
- 1 year follow up
 - 11 male elite weight lifters
 - Increase training
 - Dec T
 - Dec T/C
 - Reduce training
 - T remained unchanged
 - C decrease

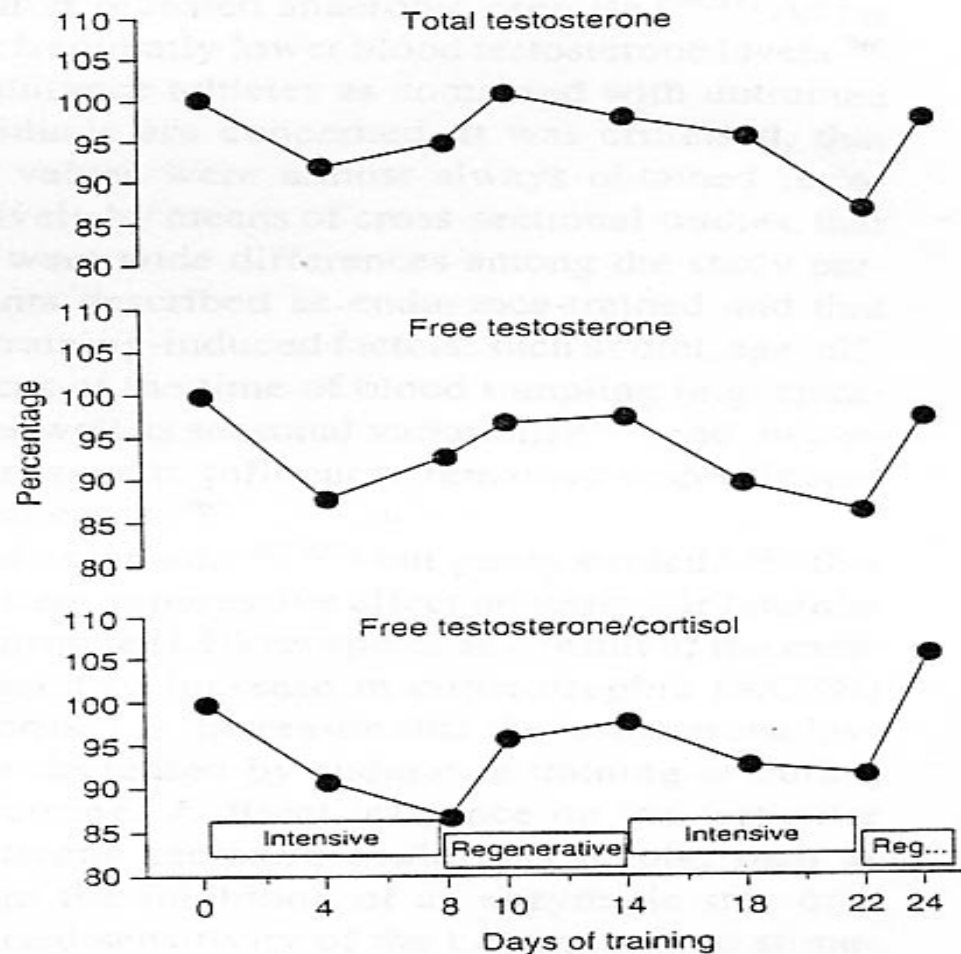


Fig. 2. Mean changes in serum total testosterone, free testosterone (as calculated by the total testosterone to sex-hormone-binding globulin ratio) and free testosterone/cortisol during several weeks, with strictly controlled (ergometric laboratory) intensive and regenerative training. The 7 endurance-trained male athletes were aged 25 ± 4 years. Maximum oxygen uptake ($\dot{V}O_{2max}$) was 60.8 ± 4.0 ml/min/kg. The initial value (day 0) had been set at '100'.

睪酮

Testosterone

- 協助肌肉生長
- 促進磷酸肌酸的合成
- 增加肌醣元儲備
- 刺激身體分泌促紅血球生成素
- 合成荷爾蒙
- Aids muscular development
- Promotes synthesis of CP
- Increase muscle glycogen store
- Stimulates EPO production
- Anabolic hormone

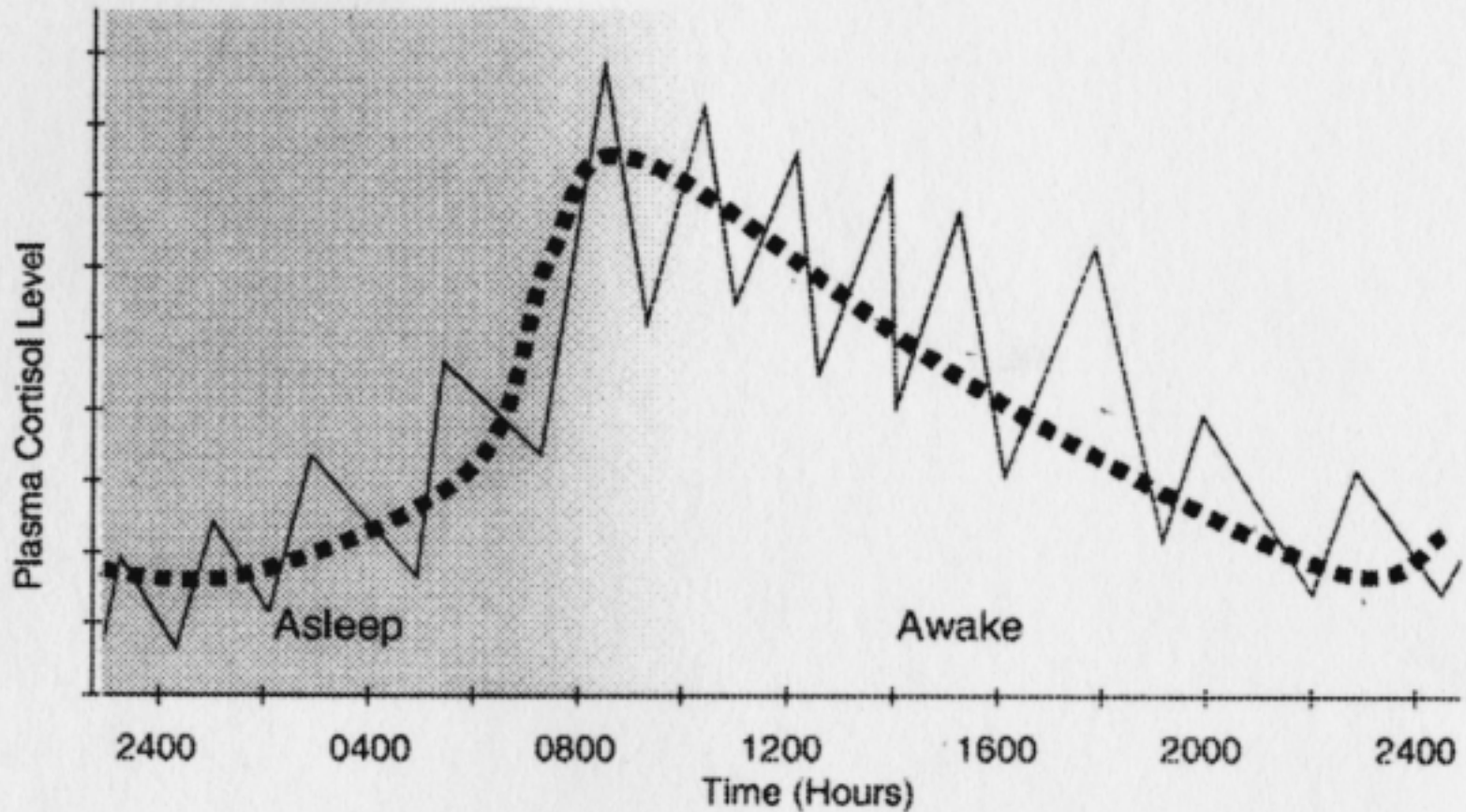
皮質醇

Cortisol

- 又稱為‘壓力荷爾蒙’
- 壓力下生產增加
 - 運動, 病, 傷, 極度溫度
 - 心理壓力(考試, 比賽)
- 功能: 調節新陳代謝及免疫系統
- Also known as the ‘stress hormone’
- Increase production in response to
 - Physical stress, illness, trauma, extreme temp.
 - Psychological stress (examination, competition)
- Function : regulate metabolism and immune system

釋放皮質醇的生理節奏

Circadian pattern of cortisol release



Circadian Pattern of Cortisol Release

睾酮 / 皮質醇值 T/C Ratio

- 反映身體合成與分解代謝的平衡
- T/C下降
 - 分解 > 合成
 - 不利恢復
- Reflects anabolic / catabolic balance
- T/C decrease
 - Catabolism > anabolism
 - Slow recovery

困難

Difficulties

- 需相對大量的血液樣本
- 長期海外訓練
- Relatively large blood volume required
- Extensive overseas training

唾液樣本

Saliva Samples

- 100% 游離及含活性
- 份子細小及高油溶性 - 濃度不受唾液流量影響
- 濃度比較低 - 高敏感度的測試
- 100% unbound & biological active
- Small molecular size and high lipid solubility – concentration unaffected by salivary flow
- Much lower concentration in saliva – ultrasensitive test

唾液樣本

Saliva Samples

- 無創, 無痛程序
- 採樣可於家中完成
- 樣本相對穩定, 簡化貯存及運輸程序
- Non-invasive, painless procedure
- Sample collection can be completed at home
- Samples are relatively stable that simplifies storage and transport procedure

試條測試

Dipstick Test

- 可攜式手提儀器
- 樣本無需特別處理
- 5分鐘內得悉結果
- 80 ul 全血或血漿
- 適合海外服務
- Portable, handheld device
- Requires no sample pretreatment
- Results within 5 min
- 80 ul whole blood or plasma
- Suitable for overseas support

Reference Test
↓ ↓

Cortisol Concentration (ng/mL)



0

20

80

320

640

1280

Personal Analyzer for Rapid Tests (PART)



睪酮及皮質醇 – 血清, 唾液比較

T&C - Serum & saliva comparison

(Obminski & Stupnick, 1987)

- 12名精英空手道運動員
- 5名精英三項鐵人運動員
- 唾液及血清樣本數值高度相關
($r=0.874$, $p<0.001$)
- 12 elite athletes in karate
- 5 elite triathletes
- Salivary & serum values were strongly correlated ($r=0.874$, $p<0.001$)

唾液皮質醇的應用

Application of saliva cortisol measurement

- 監控恢復
- 比賽壓力
- 長期心理壓力
- Recovery monitoring
- Pre-competition stress
- Chronic psychological stress

高爾夫球員於訓練及比賽中的壓力

Stress experienced by golfers during practice & competition

(Mckay et al, 1997)

- 15名職業高爾夫球員
- 於比賽及訓練中收集數據
 - 擊第一球前
 - 第6洞, 12洞及18洞後
- 量度 / 測量
 - 比賽焦慮問卷
 - 唾液皮質醇
 - 心率
- 15 professional golfers
- Data collected during a competition & a practice
 - Prior to tee off
 - After hole 6, 12 & 18
- Measurement
 - Competitive state anxiety inventory 2
 - Salivary cortisol
 - Heart rate

結果

Findings

- 比賽時(相對訓練)
 - 皮質醇上升
 - 心率上升
 - 焦慮上升
 - 自我信心下降
- 於比賽及訓練時
 - 擊第一球前皮質醇值最高
 - 焦慮於比賽期間沒有改變
- During competition (compared to practice)
 - Elevated cortisol
 - Elevated HR
 - Elevated anxiety
 - Lower self-confidence
- For both competition & practice
 - Highest cortisol prior to tee off
 - Anxiety did not change during the game

柔道比賽引致的皮質醇, 睪酮及心理反應 Cortisol, testosterone and psychological responses to Judo competition

(Salvador et al, 2001)

- 17名男性柔道運動員
- 數據於休息日及比賽日進行
 - 第一場賽事前1小時
 - 第一場賽事前30分鐘
- 測量
 - 唾液皮質醇, 睪酮
 - 心理問卷 STA1 & POMS

- 17 male judo athletes
- Data collected in resting sessions & competition day
 - 1 hr before 1st combat
 - 30 min before 1st combat
- Measurements
 - Salivary C, T
 - Psychological inventories – STA1 & POMS

結果 Findings

- 比賽前(相對休息日)
 - 皮質醇上升
 - 焦慮上升
- 所有運動員(n=17)
 - 休息日及比賽日的
睪酮反應相約
- Before competition
(compared to rest day)
 - Higher C
 - Higher anxiety
- For the whole group
(n=17)
 - T response was
similar between
competition & rest
days

結果 Findings

- 部份運動員 (n=6)
 - 比賽前睪酮比基本值上升 > 15%
 - 比賽前30分鐘的皮質醇值較高
 - 取勝的動機較大
- For a selected group (n=6)
 - T inc > 15% of baseline
 - Larger C at 30 min prior to first combat
 - Higher motivation to win

研究計劃 - 利用唾液皮質醇測定比賽壓力

Research proposal - Application of salivary cortisol in assessment of pre-competition stress

- 第一部份:於實驗室環境下比較不同測量壓力的方法
 - 唾液皮質醇
 - 生物反饋
 - 心理問卷
- Part 1: To compare different means of assessing stress under laboratory setting
 - Salivary cortisol
 - Biofeedback
 - Psychological inventory

研究計劃 - 利用唾液皮質醇測定比賽壓力

Research proposal - Application of salivary cortisol in assessment of pre-competition stress

- 第二部份:測量比賽壓力及其與個性的關係
 - 追求刺激
 - 應對技巧
- Part 2: To measure pre-competition stress & relation to personality traits
 - Sensation seeking
 - Coping skill

可應用範圍

Possible applications

- 用唾液皮質醇作為客觀及簡單的方法在臨場測定壓力
- 測量比賽前的壓力，可協助運動員，教練及運動心理學家處理有關的問題
- Salivary cortisol as an objective & easy to use method to measure stress is field setting
- Measuring pre-competition stress provide feedback to athletes, coaches, and sport psychologists that will help to better control the situation

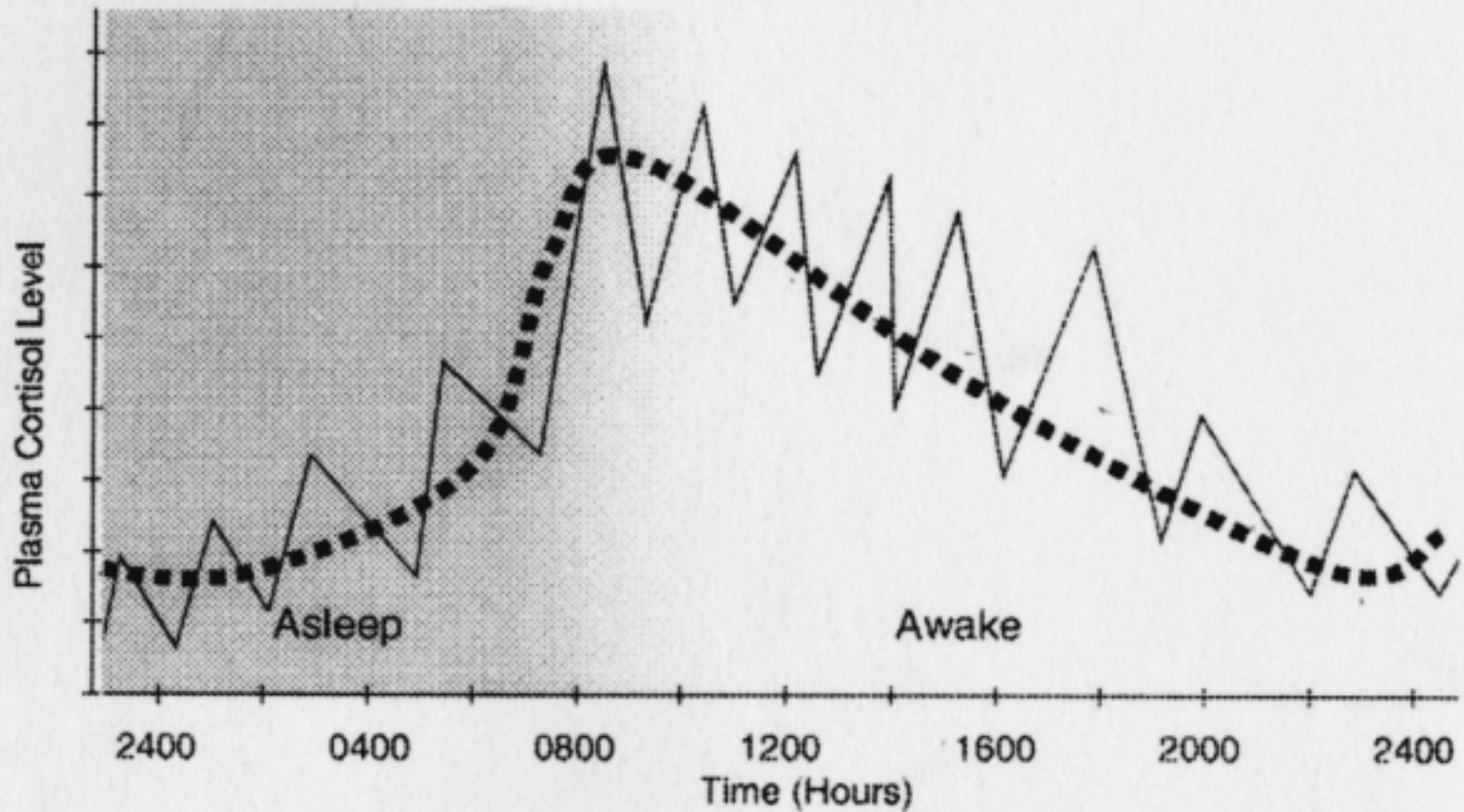
可應用範圍

Possible applications

- 加深了解比賽壓力跟個性的關係, 並協助教練及運動心理學家為個別運動員採用最佳的對策
- Better understand the relationship between pre-competition stress & personality traits help coaches & sport psychologists to adopt the best strategy for individual athletes

釋放皮質醇的生理節奏

Circadian pattern of cortisol release



Circadian Pattern of Cortisol Release

皮質醇覺醒反應

Cortisol response to awakening

- 唾液皮質醇於覺醒首30分鐘上升50-70%
- 不受以下因素影響
 - 年齡, 睡眠時間, 覺醒時間, 鬧鐘等
- Salivary cortisol increases by 50 – 70% during the 1st 30 min after awakening
- Not significantly affected by age, sleep duration, time of awakening, use of alarm clock

皮質醇醒覺反應跟心理狀況的關係

Cortisol response to awakening associates with psychological variables

- 過往數年的長期壓力
- 自我評估過去一個月所受壓力
- 耗竭
- 長期痛症
- Chronic stress during past year
- Perceived stress during last month
- Burnout
- Chronic pain

可應用在運動員身上嗎？

Any possible application on athletes?

生化監控 – 高原訓練及低氧艙

Biochemical monitoring in altitude training & hypoxic chamber

- 在額外壓力下監控恢復情況
- 對低氧刺激的反應
- 鐵貯備
- 個人化的計劃
- Recovery monitoring under the additional stress
- Response to hypoxic stress
- Iron status
- Individualized prescription

低氧環境引致的主要生化及生理反應

Major biochemical & physiological changes upon hypoxic exposure

- 換氣過急
 - 酸鹼緩衝能力下降
 - 高強度運動能力下降
- 肌糖原結合能力下降
 - 減慢恢復
- Hyperventilation
 - Reduce buffering capacity
 - Reduce capacity for vigorous exercise
- Decrease muscle glycogenesis
 - Slow down recovery

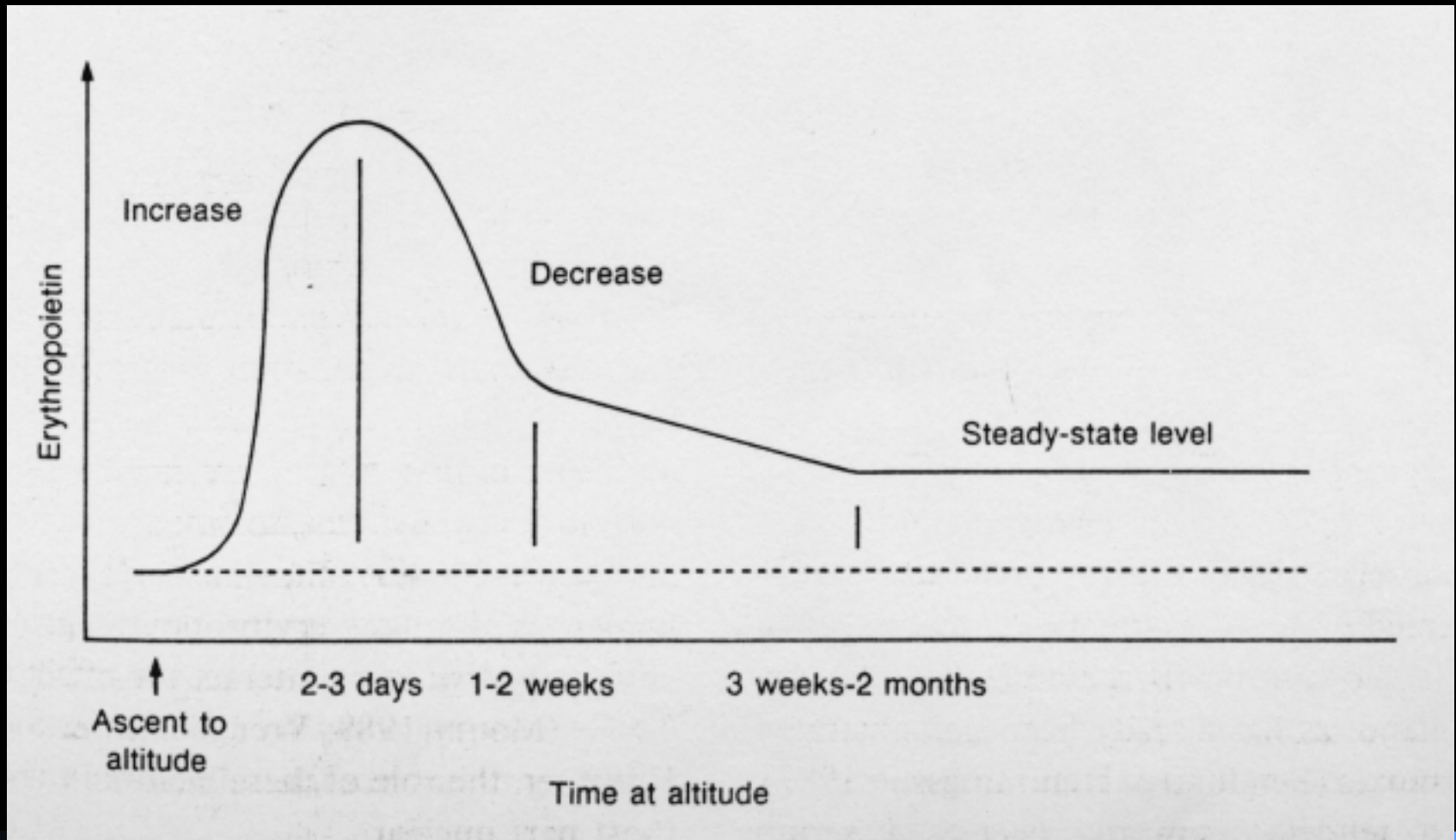
低氧環境引致的主要生化及生理反應

Major biochemical & physiological changes upon hypoxic exposure

- 利尿荷爾蒙上升
 - 血漿減少
- 紅細胞製造增加
 - 通過EPO上升
 - 鐵需求上升
- Increase in diuretic hormone
 - Loss of plasma
- Increase in red cell production
 - Mediated by inc. in EPO
 - Increase need for iron

高原引起的EPO反應

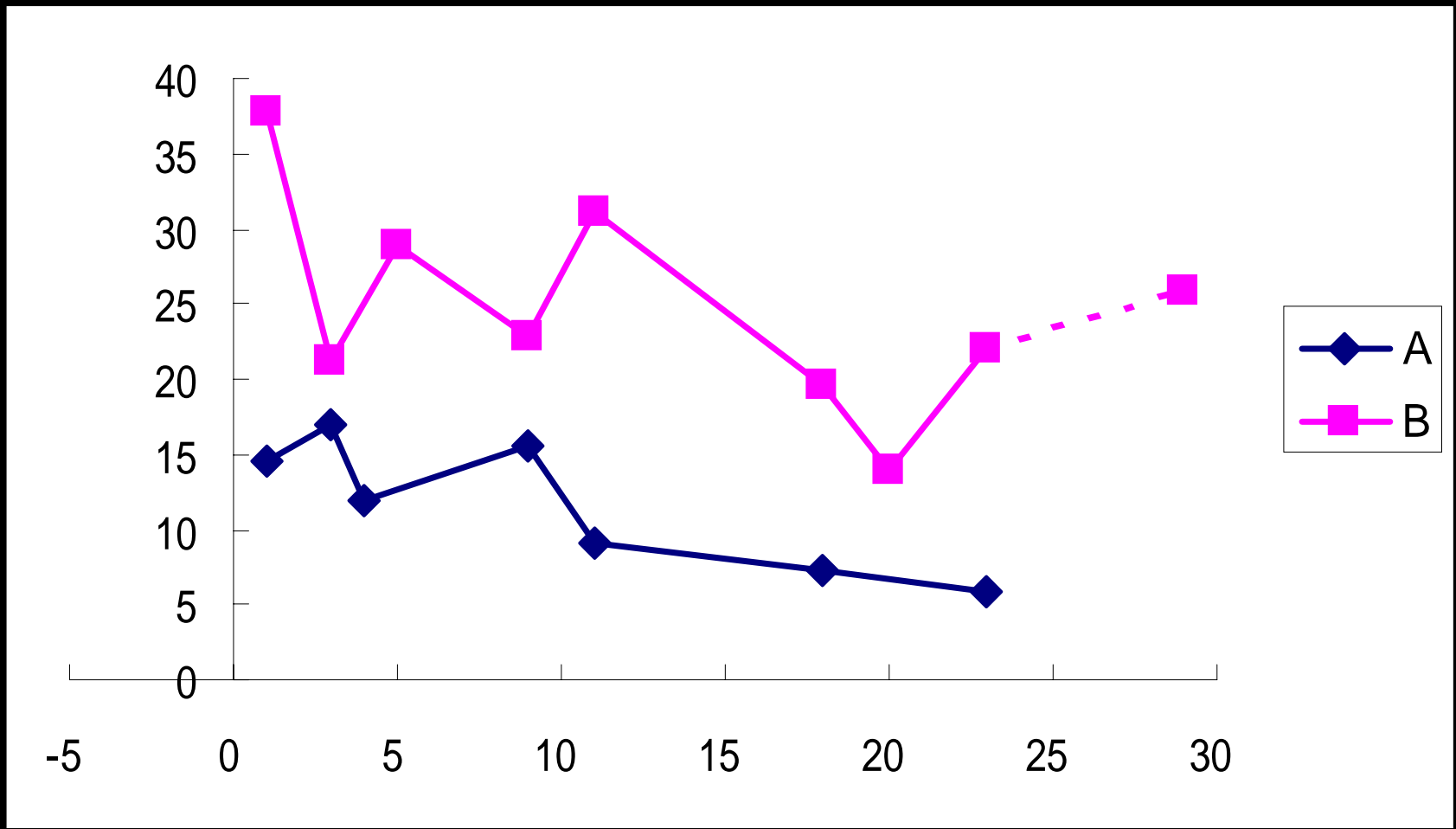
EPO response to altitude



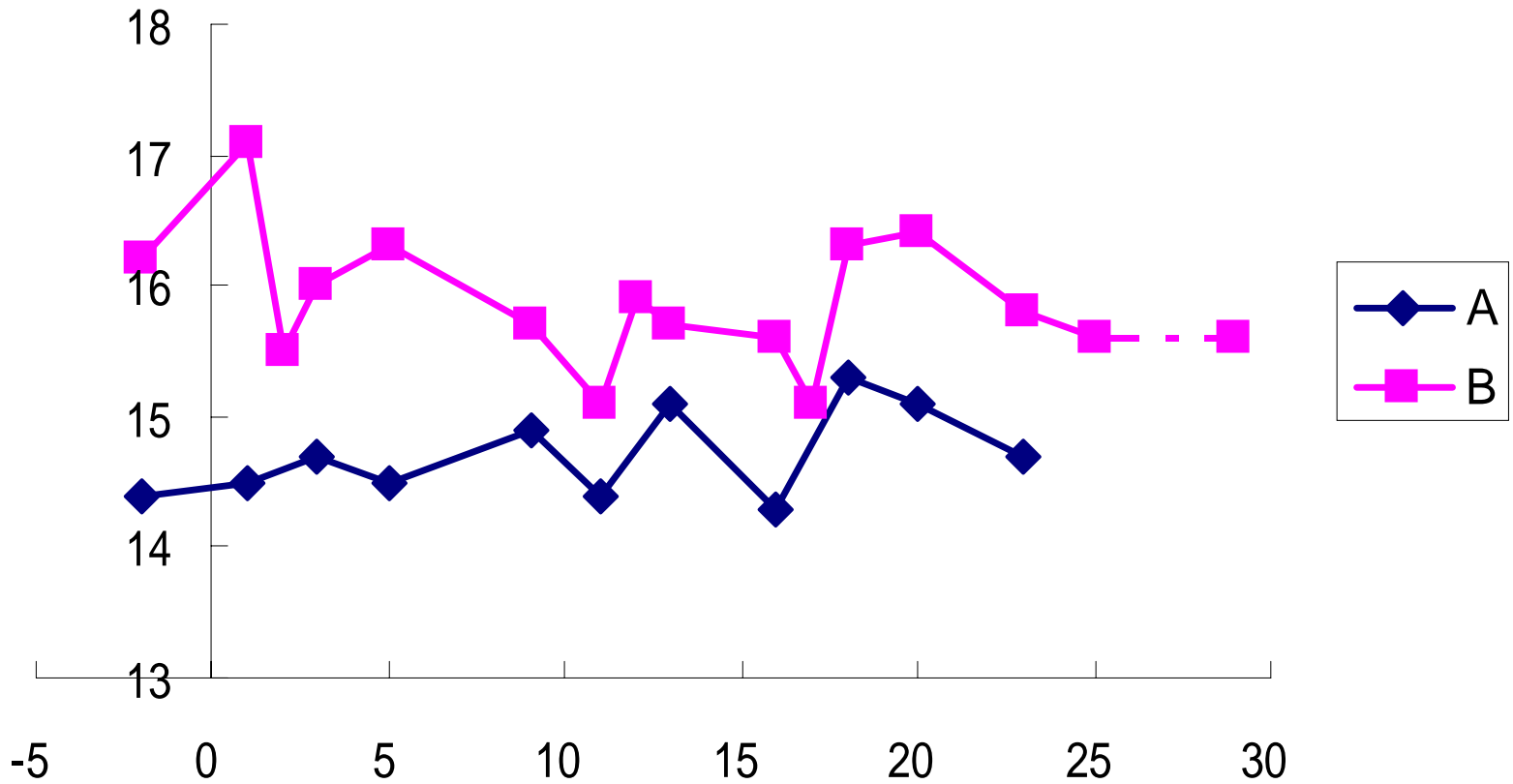
低氧艙休息 (27 夜)

Overnight stay in hypoxic room
(27 nights)

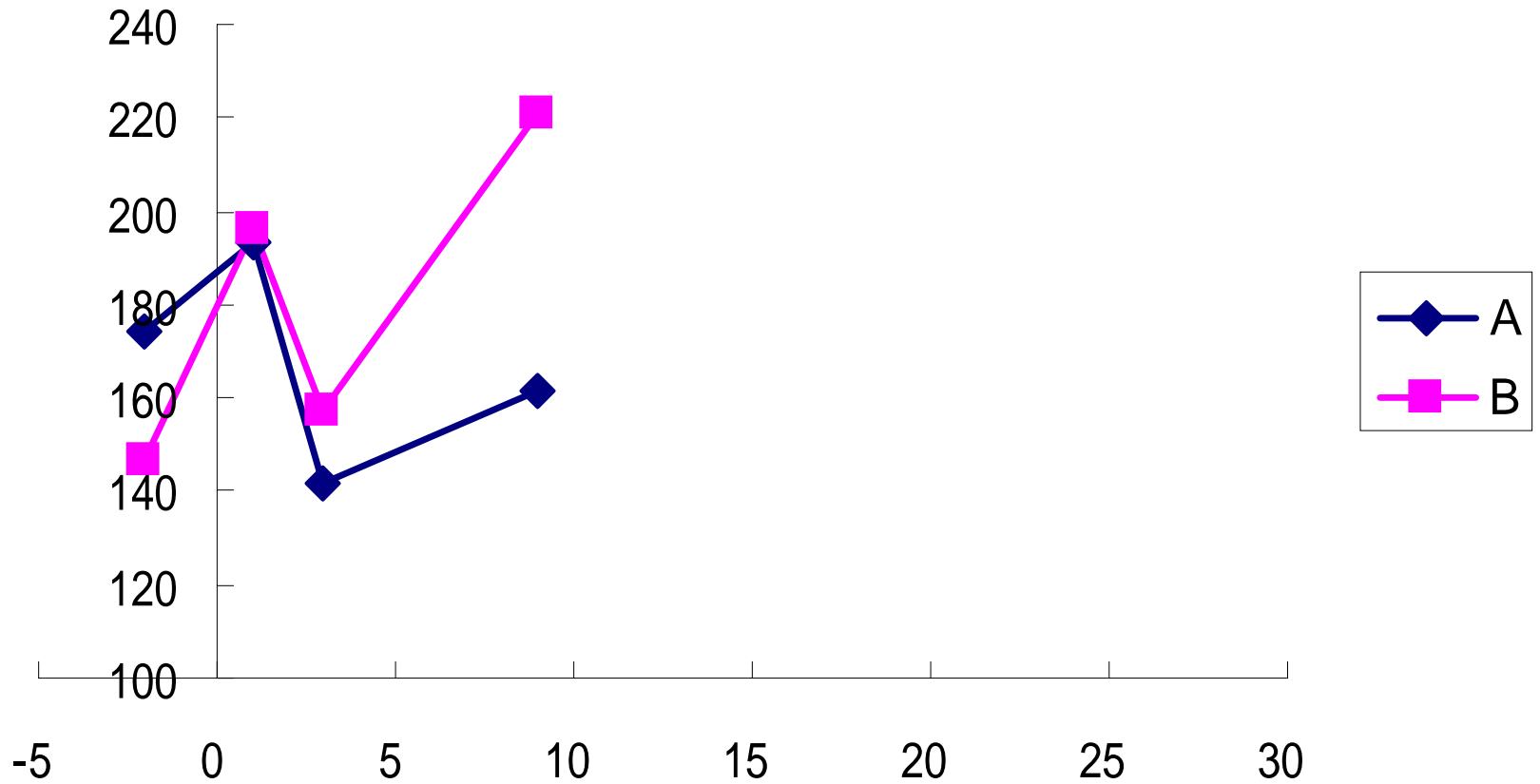
促紅細胞生成素 EPO



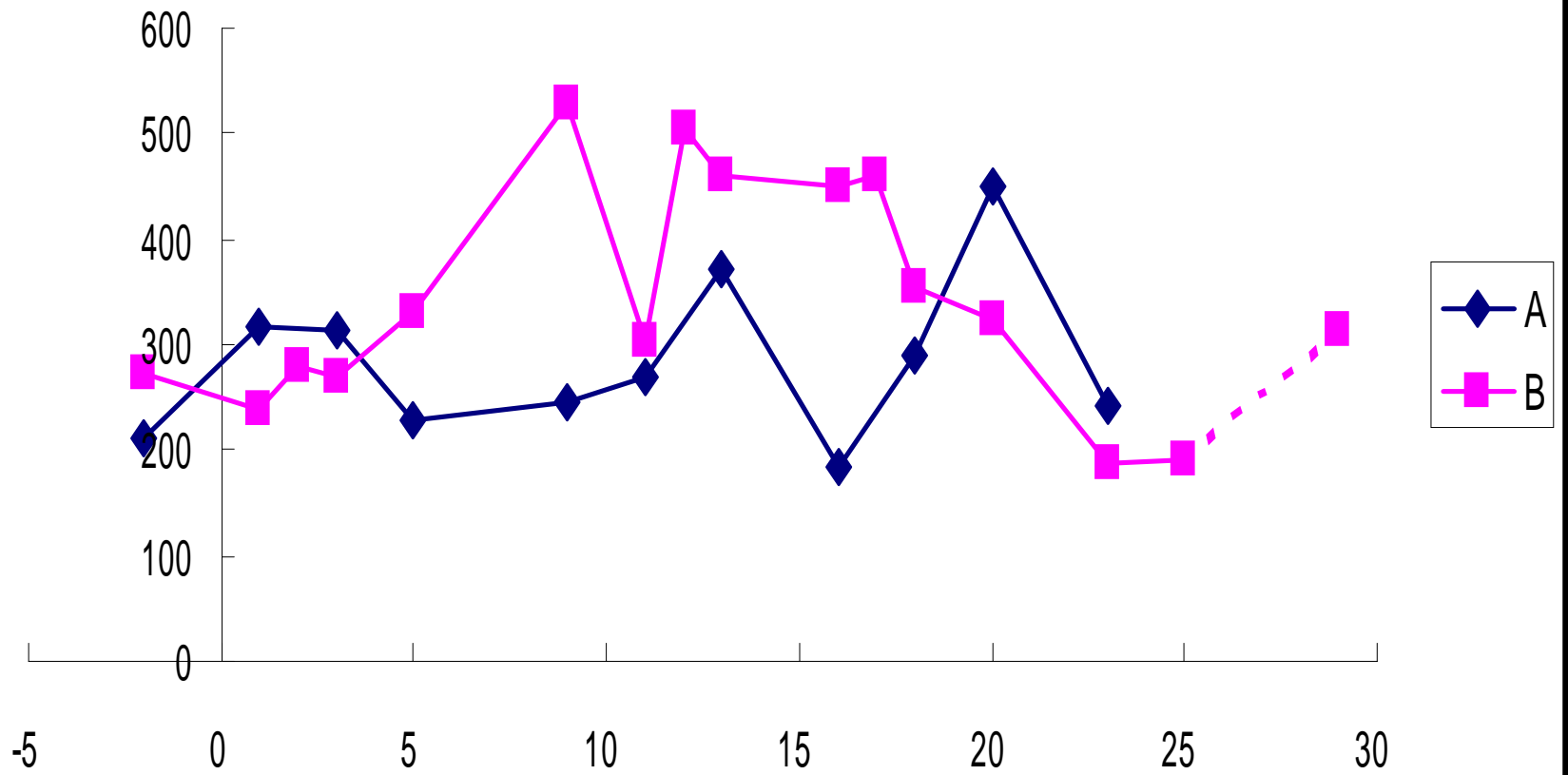
Haemoglobin 血色素



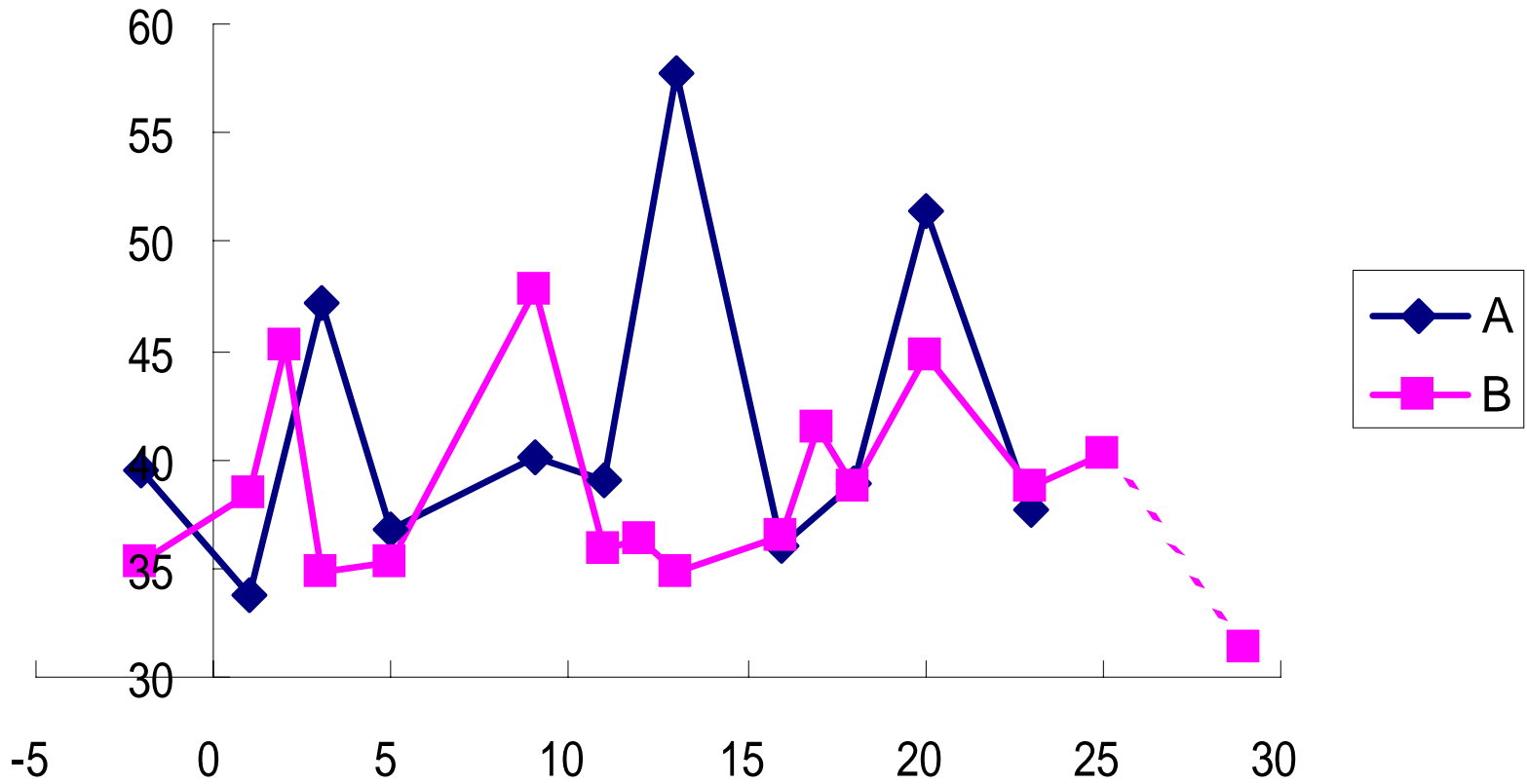
鐵蛋白 Ferritin



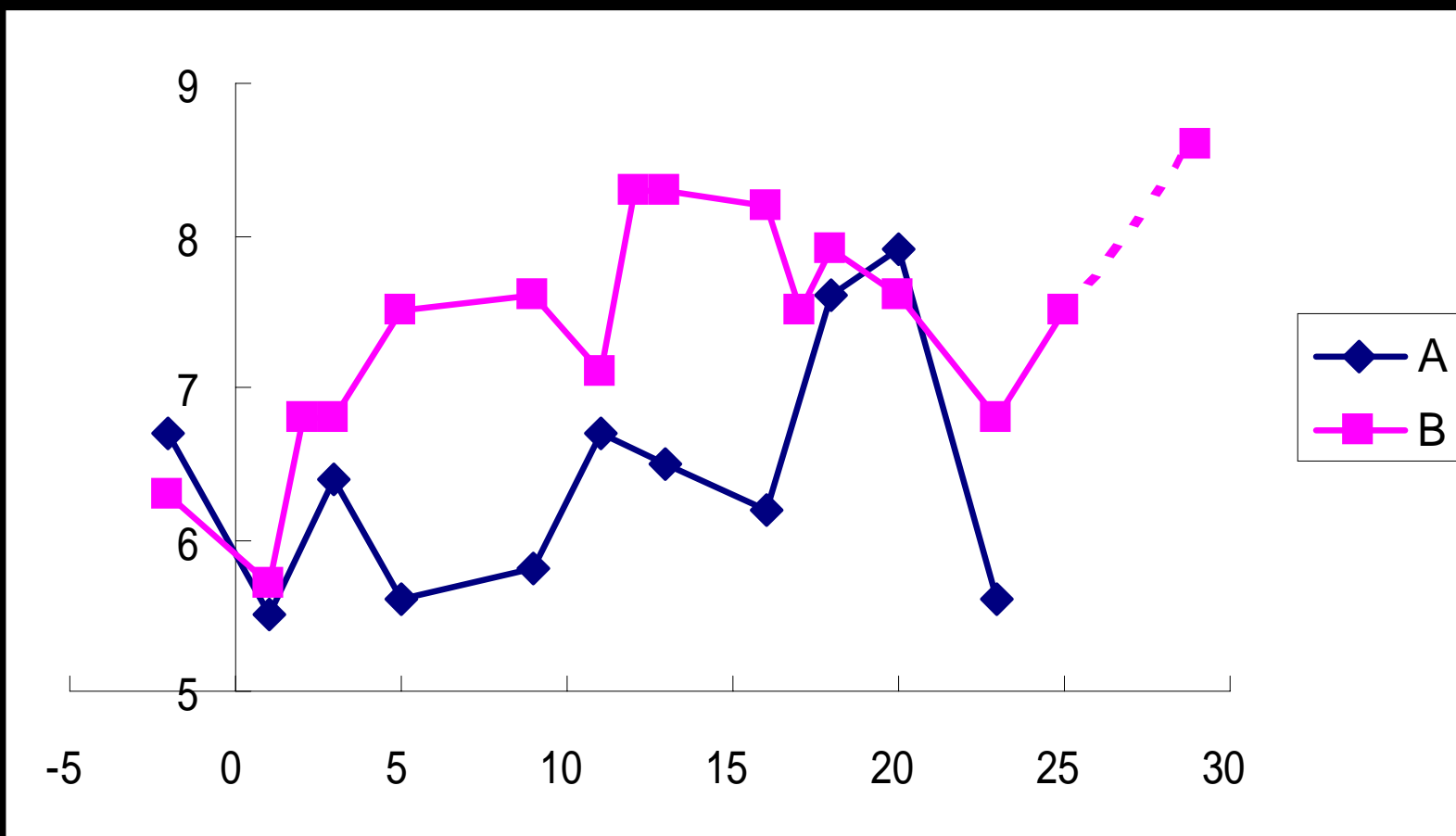
CK



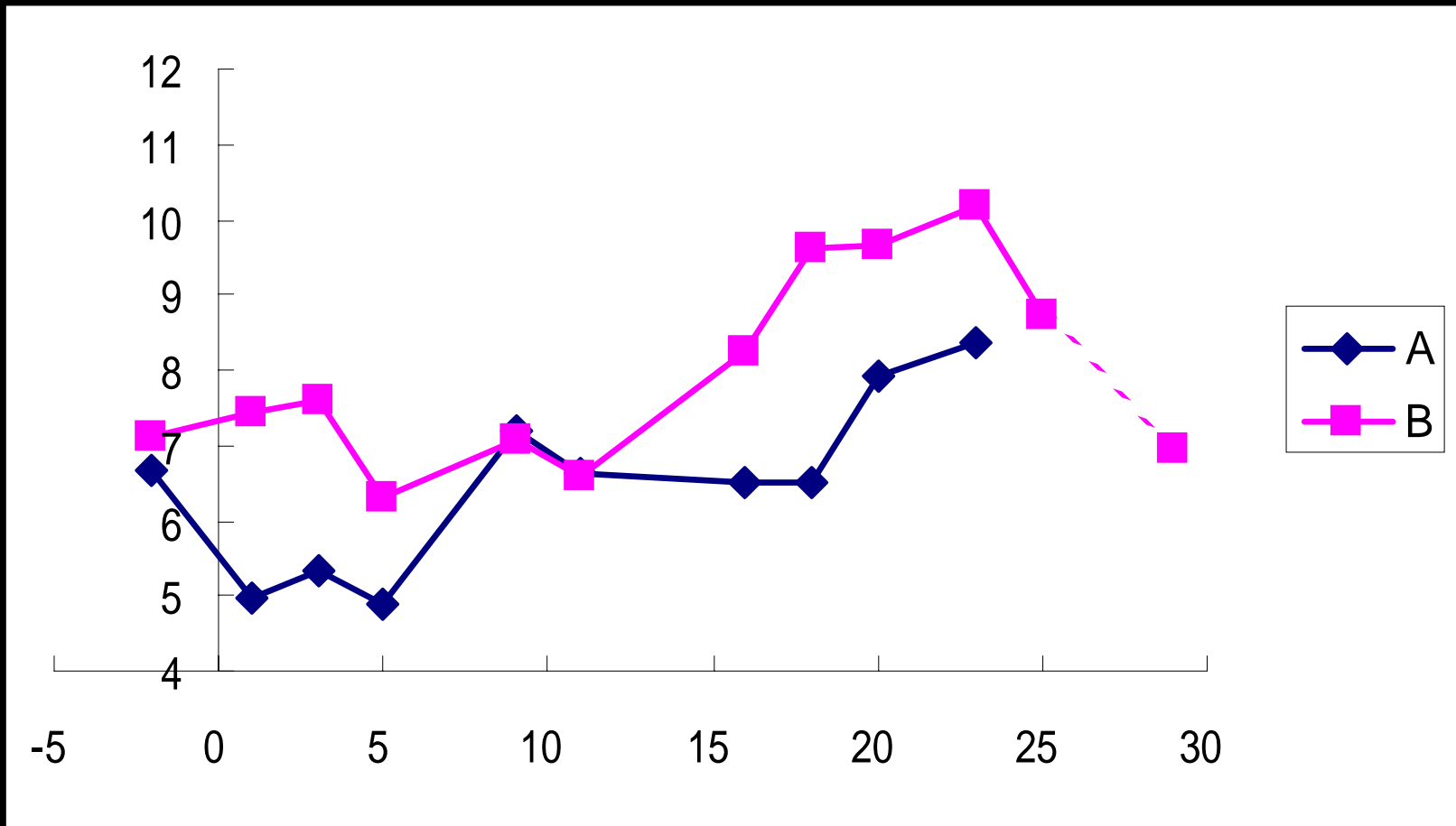
尿素 Urea



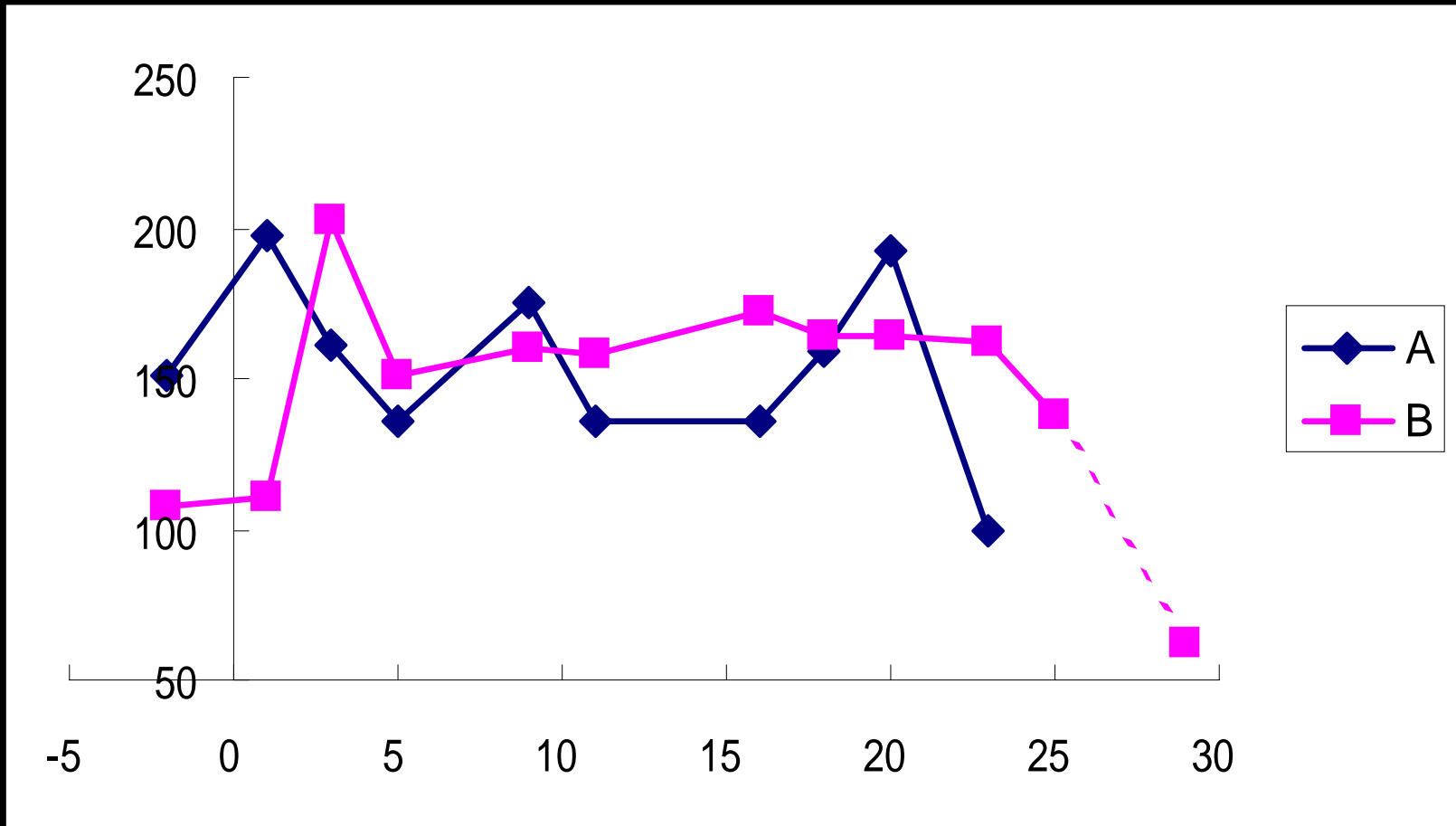
尿酸 UA



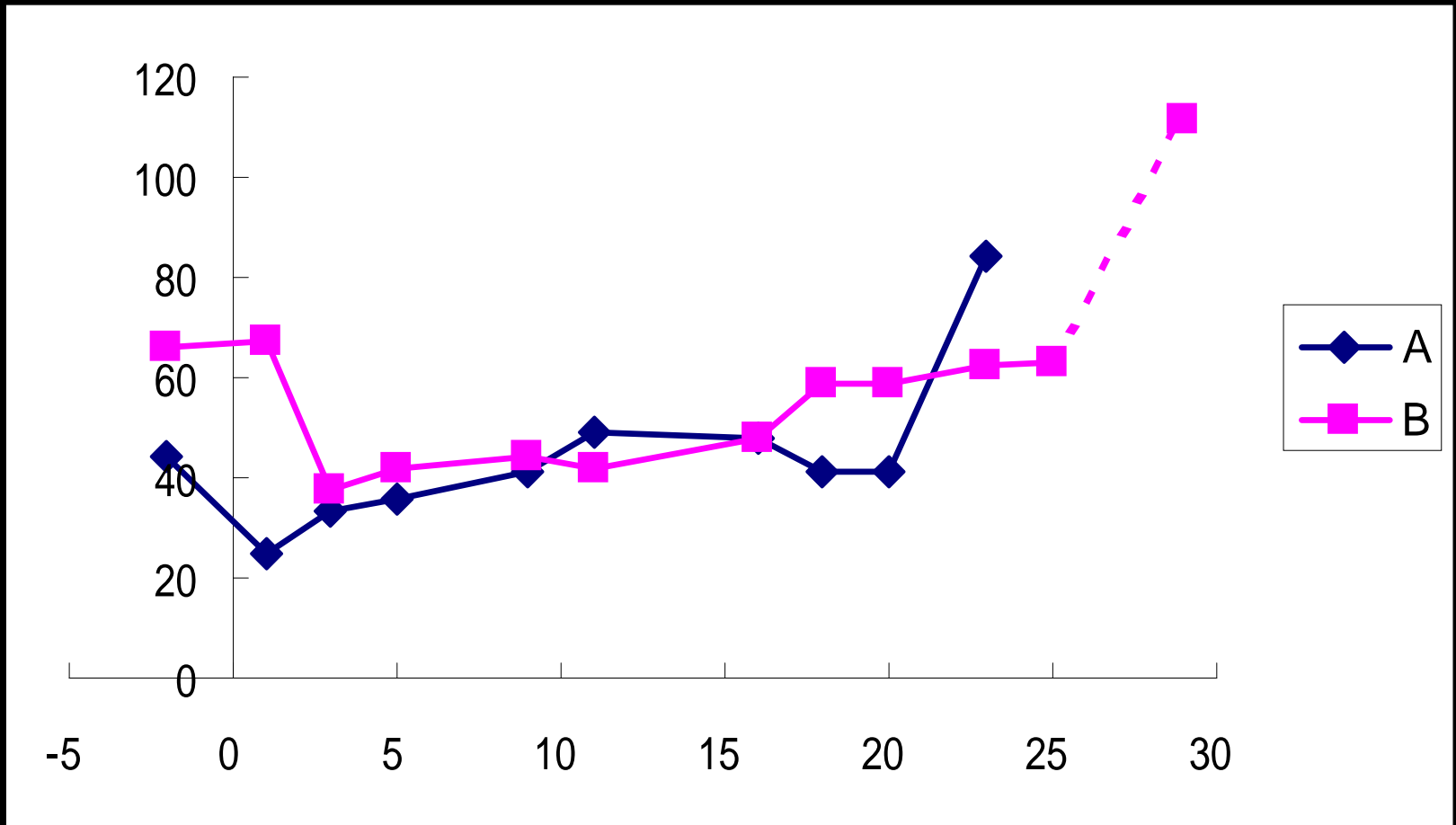
睾酮 Testosterone



皮質醇 Cortisol



T/C



提議

Recommendations

- 測量EPO可用以估計身體對低氧的反應
- EPO反應資料可用以優化低氧刺激變數
- EPO may predict adaptability to hypoxic stress
- EPO response provide information to optimize variables of hypoxic stay

提議

Recommendations

- 訓練監控相當重要，特別對沒有經驗的運動員
 - 鐵貯備
 - 水平衡
 - 能量系統
 - 恢復情況
- Training monitoring is important particularly for inexperienced athletes
 - Iron status
 - Hydration status
 - Energy system
 - Recovery status

其他適用指標

Other suitable parameters

- 血管內壁生長因子
- 轉鐵蛋白受體
- VEGF
- Transferrin receptor

運動員的鐵貯備

Iron status of athletes

- 運動員較容易患上缺鐵情況
- 缺鐵
 - 貧血
 - 隱性缺鐵 → 運動能力下降
- Athletes are at a greater risk of iron deficiency
- Iron deficiency
 - Anaemia
 - Latent deficiency → impair work capacity

鐵貯備的評定

Diagnosis of iron store

- 鐵蛋白

- 廣範被採用
- 鐵蛋白偏低代表鐵貯備下降
- 鐵蛋白水平正常不一定代表鐵貯備正常
- 運動可引發類似發炎的反應以致鐵蛋白上升
- 高強度運動可引致鐵蛋白水平持續數天上升

- Ferritin

- Widely used
- Low ferritin is a strong indicator of decreased iron store
- Normal ferritin levels do not necessarily reflect adequate iron stores
- Exercise may induce inflammatory-like response that increases ferritin level
- Increase ferritin levels may persist for a few days after strenuous exercise

運動對鐵蛋白及轉鐵蛋白受體的影響

Effects of exercise on ferritin and transferrin receptor concentrations

(Malczewska et al, 2004)

- 8名男性柔道運動員，連續10天監控
- 8 male elite judolists, 10 consecutive days

鐵蛋白	32.0±1.77 ng/ml	Ferritin
轉鐵蛋白受體	2.41 ±1.32 mg/l	Transferrin receptor
血紅蛋白	15.1 ± 6.7 g/dl	Haemoglobin

主要結果

Major findings

- 個人逐日的差異
 - 鐵蛋白 = 27.4%
(範圍: 16-44%)
 - 轉鐵蛋白受體 = 6.7%
(範圍: 4-15%)
- Within subject, day to day variability
 - Ferritin = 27.4%
(range: 16-44%)
 - sTfR = 6.7%
(range: 4-15%)

主要結果

Major findings

- 鐵蛋白跟以下指標有顯著相關
 - 早前一天的訓練量
 - 同天一的CK
- 轉鐵蛋白受體跟訓練量及CK沒有顯著相關
- Ferritin significantly correlated to
 - Training loads on the preceding day
 - CK on the same day
- sTfR did not correlate with either training loads or CK

‘轉鐵蛋白受體’
比
‘鐵蛋白’
更適合用作量度
運動員的
鐵貯備水平

sTfR
is a better index than
ferritin
for monitoring
iron status,
particularly for athletes

鐵貯備相關指標

Iron status related parameters

- 血清鐵
- 轉鐵蛋白
- 轉鐵蛋白受體
- 總鐵結合蛋白
- 轉鐵蛋白飽和度
- Serum iron
- Transferrin
- Transferrin receptor
- TIBC
- Transferrin saturation

其他指標

Other parameters

- 酮體
- 氨
- 滲克分子濃度
- 肌肉疲勞
 - CK
 - 肌紅蛋白
 - 脂肪酸結合蛋白
- 唾液IgA
- Ketones
- Ammonia
- Osmolality
- Stress to muscle
 - CK
 - Myoglobin
 - Fatty acid-binding protein
- Salivary IgA

運動生化服務範圍

Overview of the Sport Biochemistry Service

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 - 評定身體機能
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問題 Questions?